THE MODEL ENGINEER

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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

During the Coronation year, Britain has been singularly fortunate in winning honours in many fields of sport and adventure, and the achievements in motor-car racing have been particularly notable. Not the least distinguished of British cars is the Jaguar XK120C, the exploits of which, including the winning of the 24-hour race at Le Mans, have made motoring history. The model shown in this photograph was built by Mr. Rex Hays, and represents, in 1/10 scale, this famous car. It has been sent to Berlin as a representative not only of the Jaguar Company, but of the British motor industry generally, in an international exhibition, where it will be shown in company with other exhibits demonstrating British achievements during 1953, including the conquest of Mount Everest.

SMOKE RINGS

Models Lead the Way

IT IS well known that most shipbuilders, before embarking on the construction of full-size craft, almost invariably build models, not only for towing tests and other experimental purposes, but also to give prospective customers an idea of the appearance of the finished vessels. The idea of a free-lance amateur-constructed model providing inspiration for a full-size boat, however, may surprise some of our readers. A visitor to this year's "M.E." Exhibition, who was planning to have a full-size cabin cruiser built, became very interested in some of the model boats exhibited, and in particular, one on the Model Power Boat Association stand, which so impressed him that he requested facilities for obtaining photographs and other particulars of this model. Needless to say, these were readily given, and the naval architect in charge of his work has been instructed to base his plans on this information. While this story certainly makes news, it is not by any means unique, and we know of several instances where amateur-built models have led the way to new developments in the design of full-size engineering and shipbuilding projects. Which provides us with yet another answer to the oft-repeated question: "What good is model engineering ?"

"The Plant Centenarian"

THIS SPECIAL train, which made two runs, headed by the two Great Northern Railway Atlantic locomotives Nos. 990 and 251, in September was very well patronised and was a great success. The two old engines which were specially brought out of retirement and put into good running order for the occasion, looked resplendent in their bright green paint and created a great deal of interest all along the route from Kings Cross to Doncaster on September 20th, and in the reverse direction a week later.

The time allowed for the 156 miles between King's Cross and Doncaster was 204 minutes, which included a stop at Peterborough so that No. 251 could take water, since her tender is not fitted with water pick-up; there were some severe p.w. checks en route, but the two engines easily kept within schedule on each stage of the journey and arrived at Doncaster nearly three minutes early.

For the return trip, the engine was A4 Pacific, *Silver Link*, on each date. On September 20th, she was allowed 150 minutes for the 156 miles, but had no difficulty in completing the run in just 146 minutes. The great thrill was a maximum speed of 96 m.p.h. when descending the long 10-mile bank from Stoke to Tallington; in fact, it was over the 105 miles from Grantham to London that the engine recovered 2½ minutes arrears of time and gained another 1½ minutes. Good going, indeed !

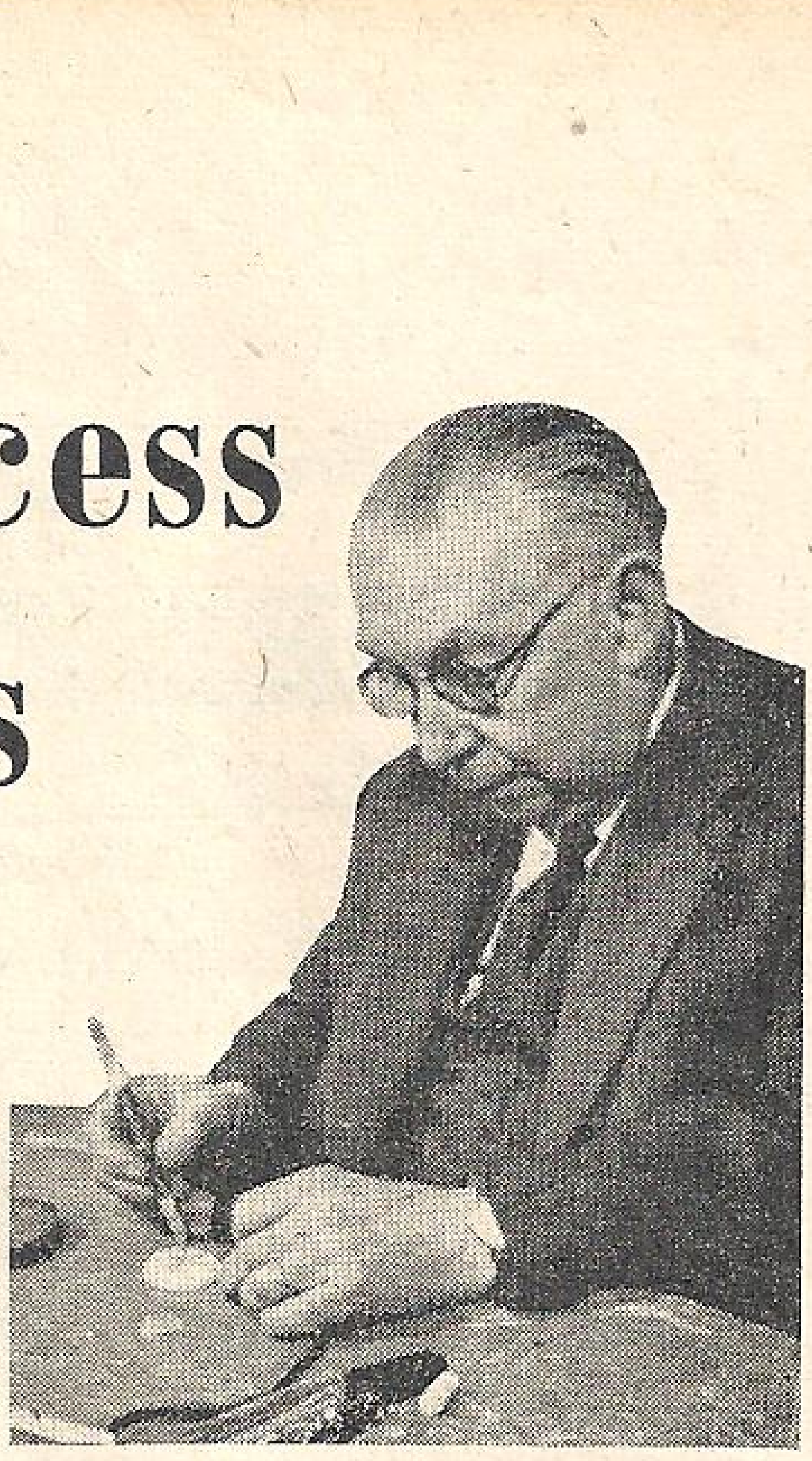
Models in Industry

IN AN article on the above subject, in the October issue of *Art and Industry*, some pertinent remarks are made regarding the value of models, not only as an aid to sales and publicity, but also in experimental work and pre-production planning. Although the great majority of our readers are amateurs who build models purely for the love of it, we think they will be interested in the appreciation of their skill and usefulness shown in the following extracts, which are quoted verbatim:—

"A good model, of whatever type or subject, is invariably considered to be a work of art. The materials used in its construction may be worthless, but the skill employed in its fabrication sends a message to all who behold it, over and above its primary purpose. . . . The craftsman in this age of machinery is rapidly dying out—but the model-maker at least remains. British industry could with advantage utilise, far more than it does, the skill of the model-making craftsman."

The "LOST WAX" Process of making castings

The report of a lecture by Mr. W. Savage to the Sutton District Model Engineering Club



Forming the wax pattern

IN response to many requests, I propose to let a little light into the subject of casting by the Lost Wax Process. The methods which I propose to speak about are mainly of dental origin, which have been known in the dental profession for many years.

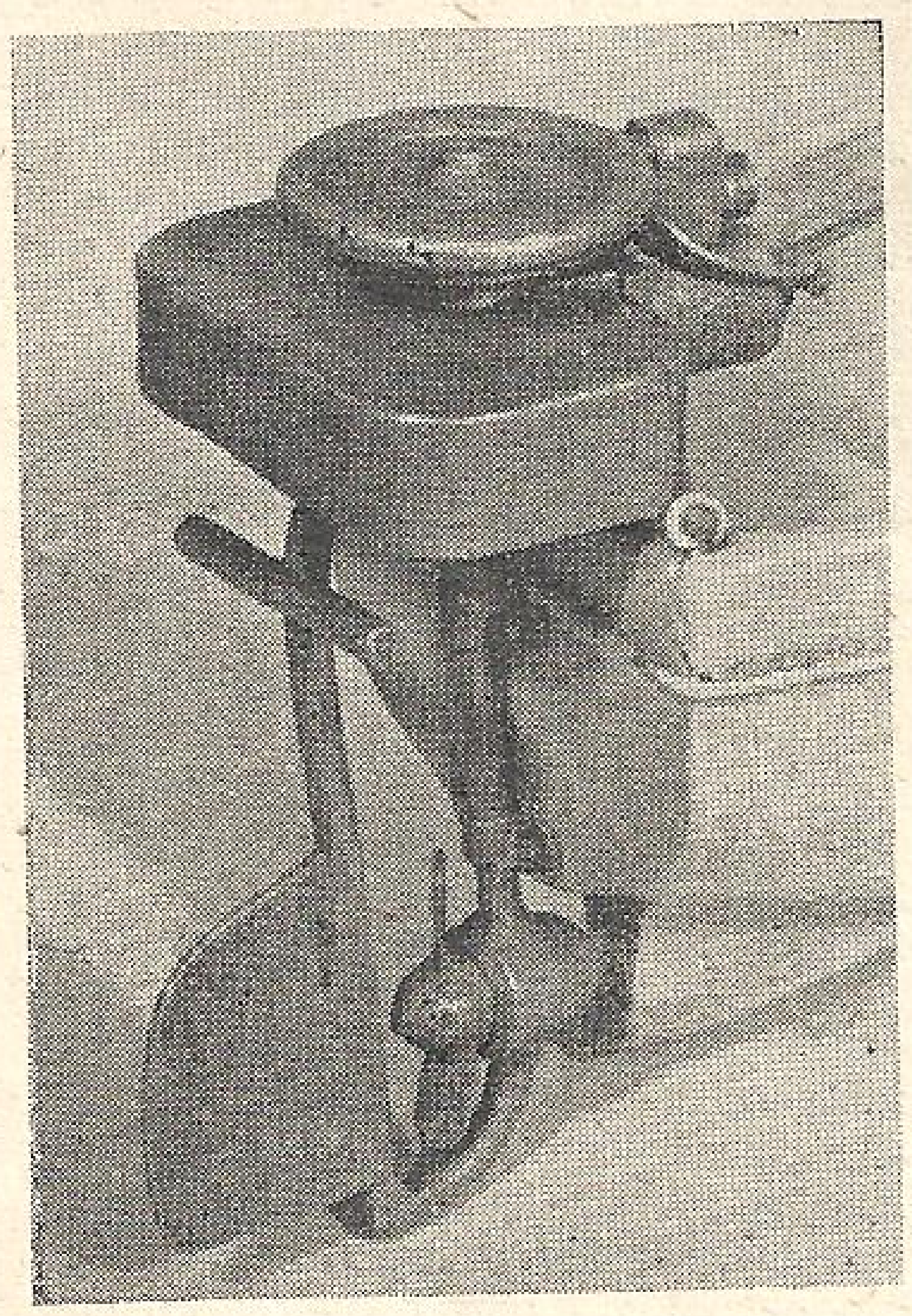
The article required to be cast is made in wax, of the type obtainable in the dental profession. The sheets of wax are made in many thicknesses, the one I propose to work in being 4 mm. thick. A pattern of the required object is first made in wax and embedded in one of the special heat-resisting plasters. The wax is then destroyed by heat, leaving a space within the plaster into which the metal is forced to produce the object required.

Silver Ivy Leaves

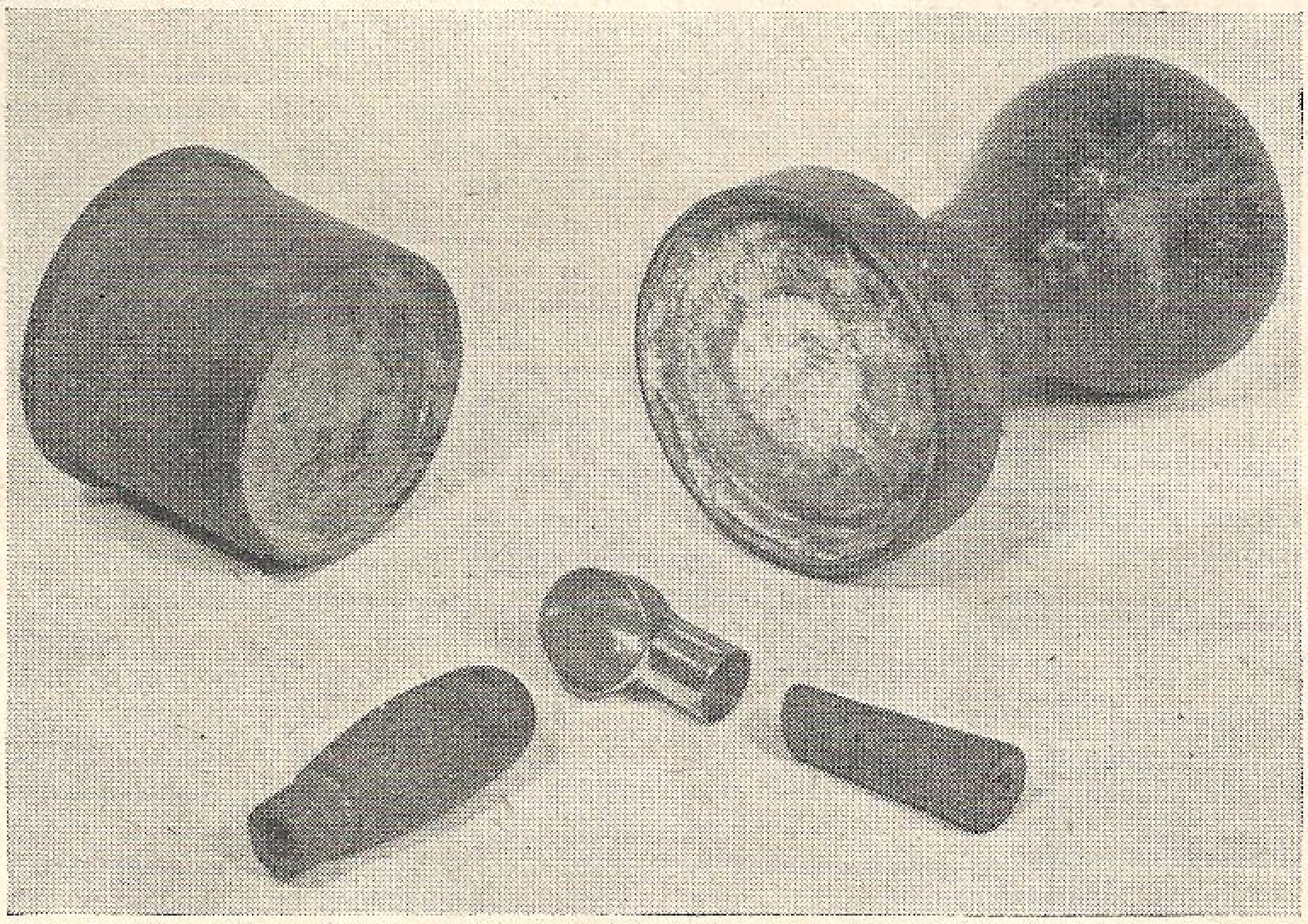
I propose first to show how to cast an ivy leaf in silver, to make it into a brooch for the adornment of our lady friends. There are several means of forcing the metal into the mould, one being by centrifugal force, known in the past as "bucket casting." To carry this out, a handle is provided, with a short chain, on the end of which is a flask and ring containing the mould. The metal having been melted on top of the mould, it is then swung in a circular motion, rather like swinging a pail of water around one's shoulder. This can be varied by using a horizontal motion, which is usually performed in these days with a spring mechanism. Another method is by forcing the metal into the mould by compressed air, or by steam pressure, which is the method I propose to demonstrate. First, we take a natural ivy leaf, and by means of plaster of Paris, we take an impression of the face of the leaf. When set, the leaf is removed from the plaster. Dental casting wax is now warmed over a spirit lamp, and gently pressed into the plaster impression of the leaf. This is now thickened slightly, to make it strong enough for the purpose for which it is intended. Having formed a leaf in wax, we now have to consider a way in for the metal. This is done by fastening, by means of heat, and, of course, into the centre of the back of the leaf, a piece of wax, formed in the shape of a wire, a little more than $\frac{1}{16}$ in. thick in diameter. In the photograph it will just be possible to see the leaf pattern in wax on the plaster impression.

Special Investments

We now take a metal ring sufficiently large to take the pattern, and using one of the special invest-

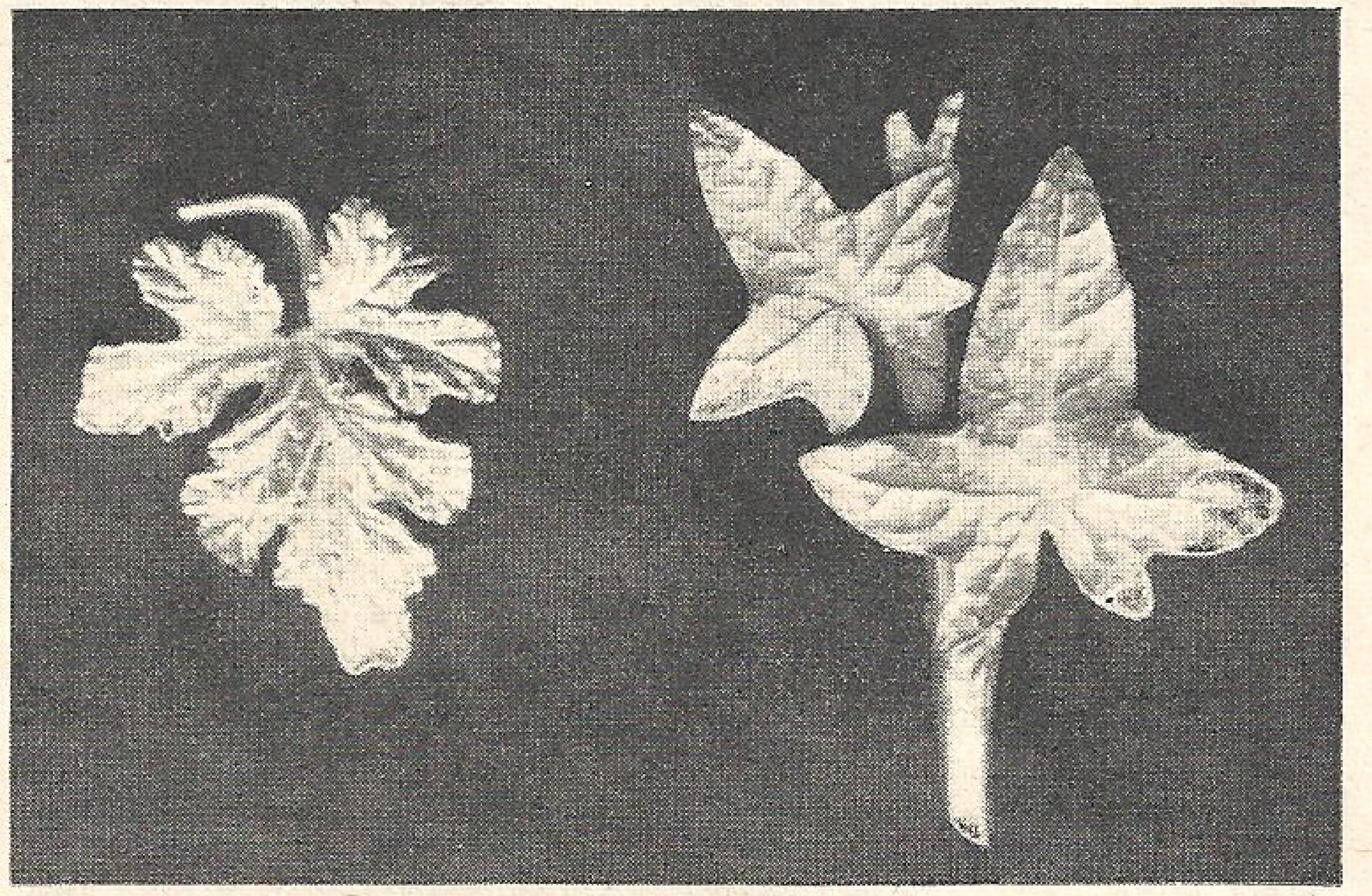


A model outboard motor cast in one piece



The open-ended ring and pressure pad, also wooden cores used in making the pattern for the ship's ventilator seen in centre

Melting the silver in depression in ring



Brooches in silver, actual size

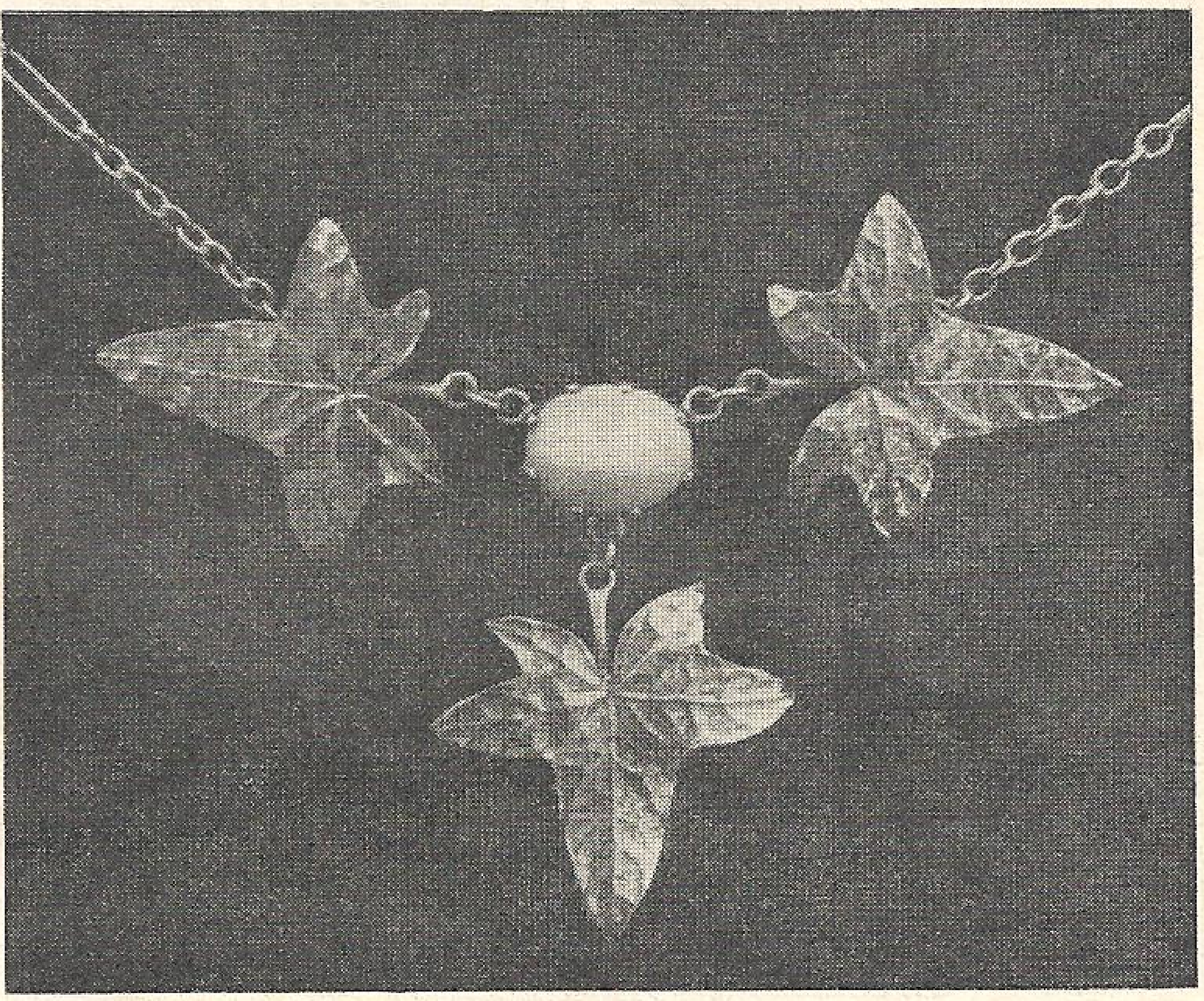
ments, which is of a plaster nature, mixed with water, the pattern is painted over with the investment. To ensure that this sticks to the wax pattern, it is a good idea, immediately before painting the investment, to paint it over with acetone. The second investment material, which is coarser in texture, is now mixed, and the ring filled with same, the leaf being sunk carefully into it, so as to be about half-way down within the ring, face downwards. The wax wire that we put in the back of the ring should just show on the top of the investment for location purposes. Having allowed the investment to set, a conical-shaped depression is cut in the top, using the wax wire as a guide, to within about ⅛ in. of the wax leaf.

Using the Pressure Pad

The ring should now be placed on a gas ring, heated slowly, and brought up to red heat. The next operation is to melt the metal in the conical-shaped depression, and bring the pressure pad of wet asbestos, quickly, and with pressure, on to the top of the ring. Steam is immediately generated by contact of the wet pad with the heated ring, which forces the metal into the space left by the destruction of the wax. This pressure should be maintained for a sufficient length of time to allow the metal to set. The whole may now be plunged into cold water, which will cause the investment to disintegrate, leaving the casting to be finished off by any suitable means. By this process, any small casting can be easily made, and though perhaps not always a success at the first attempt, it can be mastered after a little practice.

After the demonstration, a few articles cast in this process were handed round, and are shown on the photographs. They include a model outboard engine cast in one piece (nothing moves, of course), two brooches cast in silver, one being an oak leaf geranium (this was made using the *actual* leaf as a pattern) the other two ivy leaves complete on stem, an ivy leaf necklet cast in gold with hand-made setting for stone. Other photographs show the ring and presser, and a silver casting of a ship's cowl ventilator, together with the two-piece pattern on which the wax was moulded. The pressure pad is a loose fitting lid fastened to a wooden handle, with ¼ in. of asbestos millboard inside.

I am indebted to Mr. A. R. Turpin and Mr. E. T. Westbury for the photographs published with this article.



Necklet in gold, actual size

The VICKERS-ARMSTRONG South Marston Exhibition

Reported by Norman Hallows

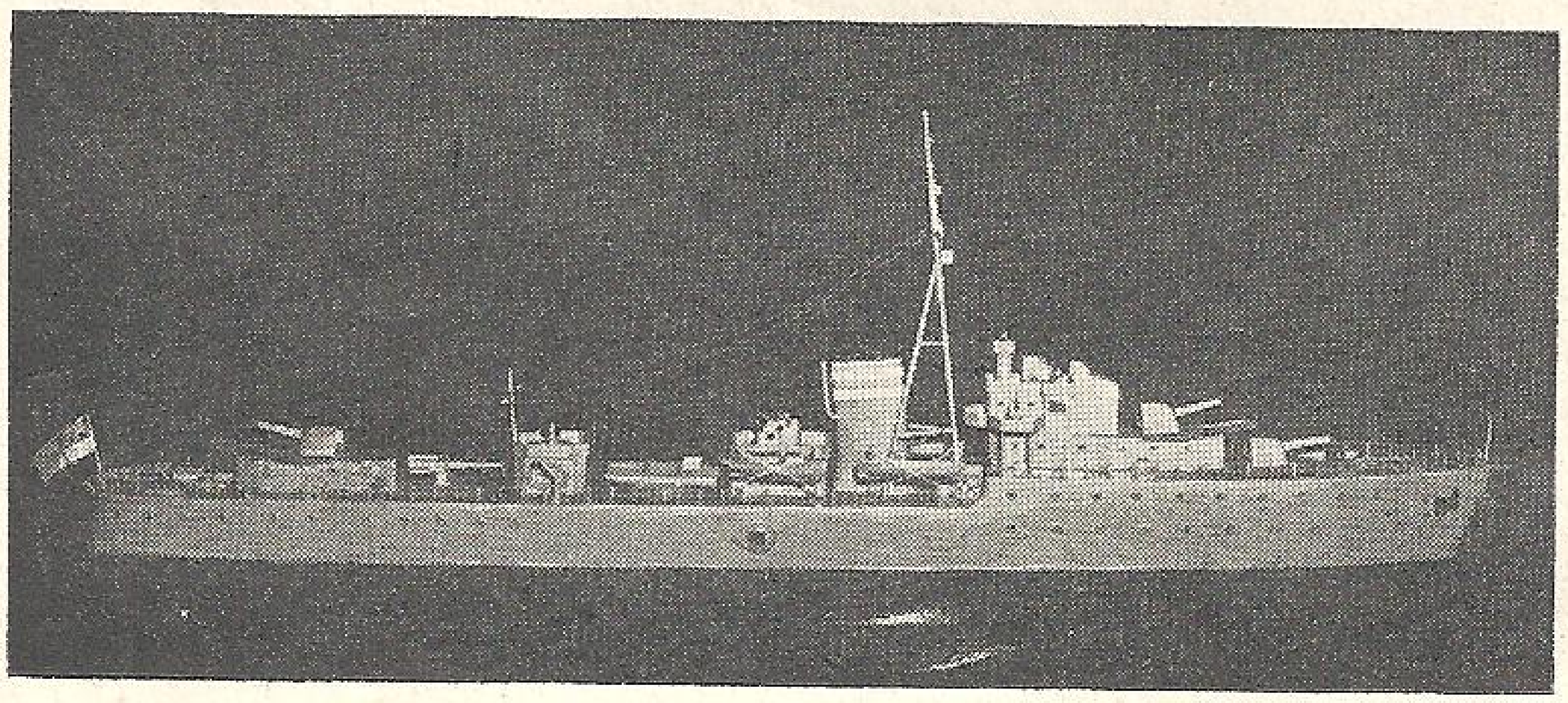
A MODEL engineering section formed part of this exhibition which was again held at the South Marston aircraft works, situated near Swindon; but this year, for the first time, entries were accepted from the company's other factories grouped in the south of England.

The exhibits in the classes reserved for general engineering work and stationary engines were not as numerous as might have been expected and, here, an opportunity was offered for displaying work of original design in the field of either steam and petrol engines or items

The model plane, fitted with 10 c.c. Ohlsson motor, shown by Mr. R. Parsons

As reports of similar exhibitions, appearing from time to time in this journal, seem to be a popular feature with readers, no excuse is needed for illustrating a representative range of the models shown, together with a brief description of some of the more outstanding exhibits.

Naturally, aircraft models tended to predominate, but sailing yachts and power boats were well represented, and classes for general and specialised arts and crafts were also included.



Mr. R. J. Gerry's "Javelin" class destroyer

of workshop equipment and special-purpose tools.

A well-constructed and highly finished aeroplane of free-lance design was shown by Mr. E. Higlett. This model has a wingspan of 62 in. and is radio-controlled with the addition of crystal control of the transmitter.

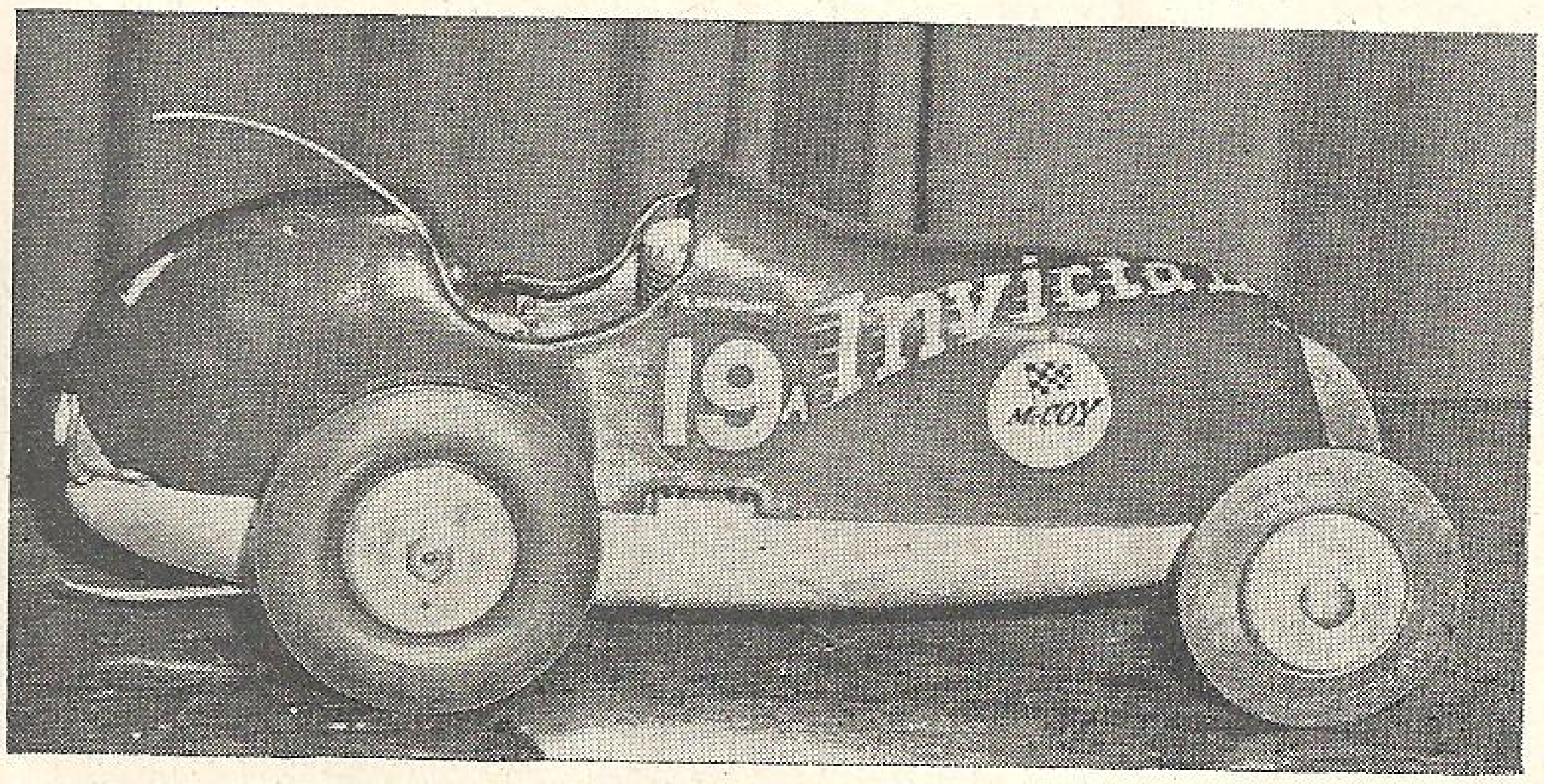
The aeroplane exhibited by Mr. R. Parsons is powered by a 10 c.c. Ohlsson motor; the designer finds that the model is very stable and easy to fly and it has already done some twenty hours in the air without mishap.

Race Cars

The Weybridge section had several race cars on view, and the model illustrated, made by Mr. E. Bridgeman and fitted with a modified, 10 c.c. McCoy engine, has the outstanding performance of clocking 112 m.p.h. to its credit, as well as winning many trophies.

Ship Models

There were models of two old-time ships and, as often happens, it is only too easy to be critical and draw attention to items of workmanship of the wrong period, such as machine-sewn sails or chromium-plated fittings.



A 112 m.p.h. race car made by Mr. E. Bridgeman

The diesel engine driven destroyer of the Javelin class, shown by Mr. R. J. Gerry, measures 40 in. overall and has very realistic deck fittings. The attention given to detail and the excellent paintwork help to place the model among the prize winners.

Mr. R. Millmore's model of a clinker-built sailing dinghy, showed much good workmanship, but a fault in the fitting of the forward decking and the free use of plywood would hardly escape the judges.

No exhibition would be complete

without a model of the *Queen Mary*, and that shown by Mr. V. Rickman is 7 ft. in length and carries a complete range of deck fittings. It is, however, no easy matter to make a satisfactory sheet-metal hull to this large scale, and the joints between the component parts are rather obvious. Moreover, too liberal painting is liable to obscure the details of the deck fittings. The four propellers are driven by an electric motor, through a worm reduction gear and two pairs of crown wheels to give the correct direction of rotation. In addition, the steering gear is operated by a small electric motor through suitable reduction gearing.

Sailing Yachts

For quality of workmanship and close attention to detail, the model sailing yachts were one of the outstanding features of the exhibition. Three of these models, were shown by the Weybridge section. One built by Mr. A. H. Pullen, is an A-class yacht, 4 ft. 4 in. in length on the water line. This boat is a candidate for next year's international races. Another yacht belongs to the 36 in. restricted class, and is also an example of fine craftsmanship. A further yacht (Mr. G. Marshall's) is to take part in next year's national races for the Marblehead class.

Although the factory is so near to Swindon, few representative model locomotives were on view, so the $2\frac{1}{2}$-in. gauge model of modified *Fayette* design at once attracted attention. This finely finished engine, built some years ago by Mr. C. Davies and his father, has won many awards in the past; but as a result, no doubt, of hard work, there is now evidence of wear in the motion and rod bearings.

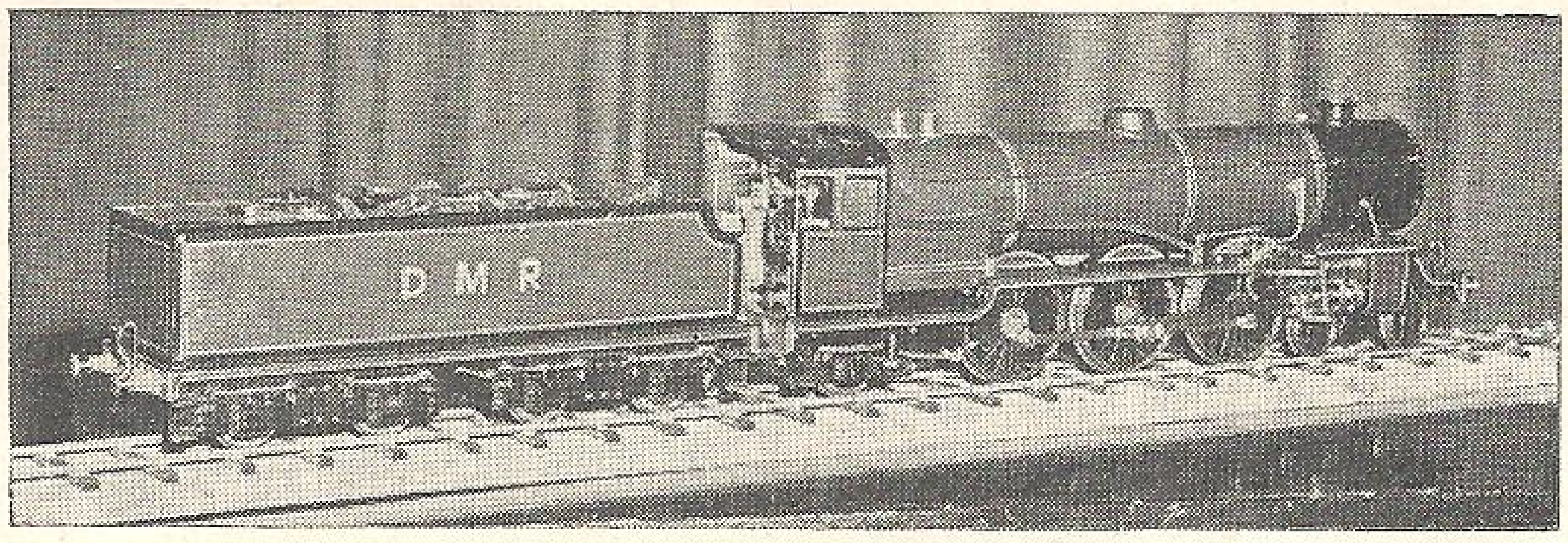
The model is fitted with a superheater as well as a mechanical lubricator driven from the front coupled axle.

A $\frac{3}{4}$-in. scale model of a dockyard locomotive is well made and is representative of its class, the excellent paintwork combined with the outstanding detail finish giving the little engine a most attractive appearance.

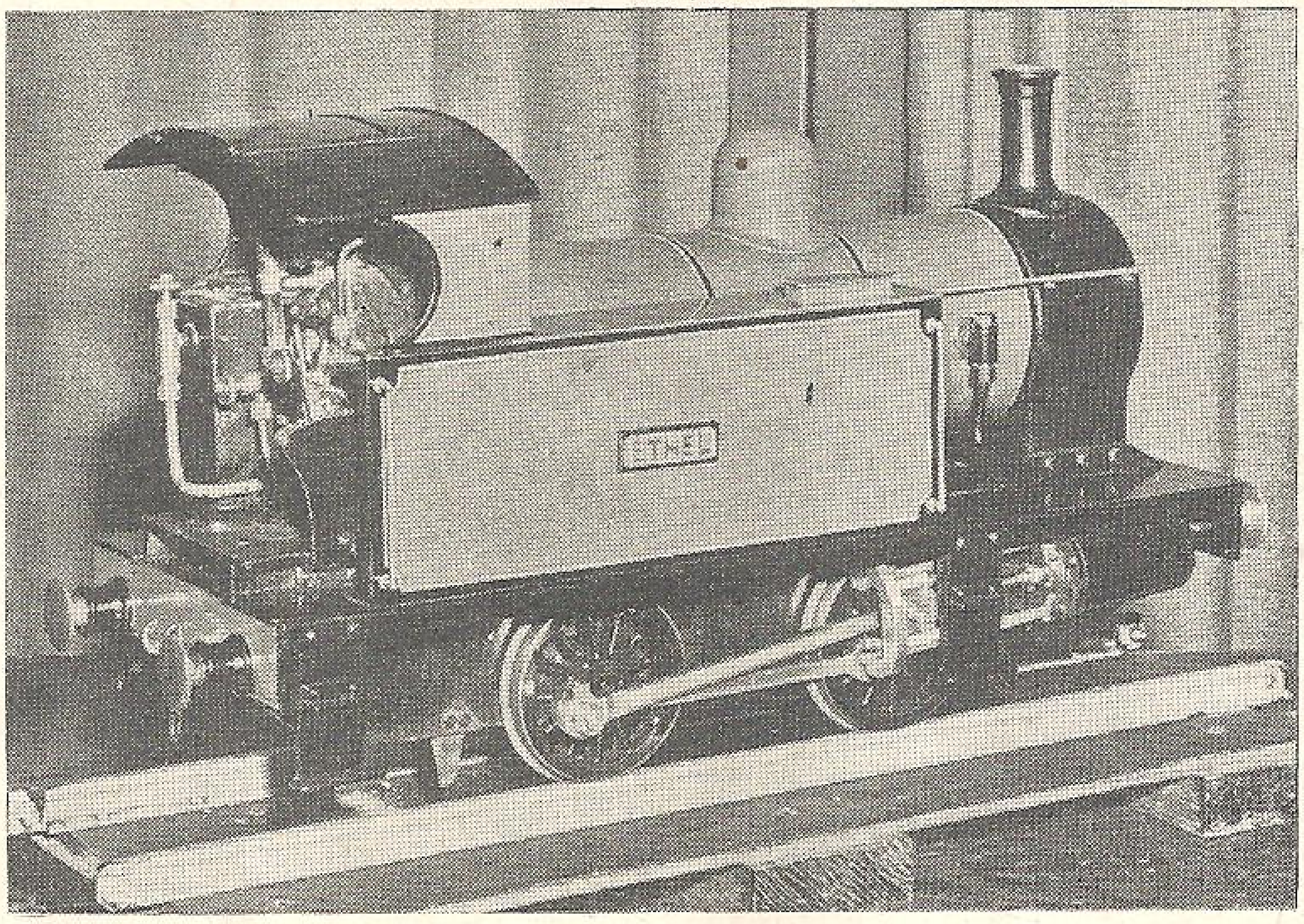
Noteworthy Craftsmanship

Sheet metal working usually enters into commercial aeroplane construction, and the examples of this craft illustrated could hardly be surpassed for fine workmanship.

Messrs. Vickers-Armstrong very kindly supplied the photographs of the exhibits selected to illustrate this article.



Mr. C. Davies' model of free-lance design



A $\frac{3}{4}$ in. scale dockyard engine from Weybridge

An example of fine workmanship and attractive design

READERS' LETTERS

● **Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.**

MODEL PETROL ENGINE PROBLEMS

DEAR SIR,—Mr. Curwen's argument in favour of negative earth ignition system is new to me. During the war, working on motor transport, I saw both systems and heard arguments in their favour. The argument for negative earth was usually zero potential on the exposed parts of the vehicle, whilst positive earth, it was claimed, reduced corrosion of the battery terminals. Doubling the speed of the magneto results in a fatter spark at the lower speeds, and that in itself may have been the solution to the problem.

My experience with the first running of a Kittiwake Major 30 c.c. engine may be of some use to the people who handle the more "peanut" sized engines. The coil is an old motor-cycle magneto rotor, with a car type condenser, and a 10,000 ohm resistor in the plug lead as a suppressor. The source of current is the usual four-volt battery, and the plug gap is 0.018 in.

The first thing necessary to get it running without flooding was to lower the float chamber about $\frac{3}{8}$ in. below that shown on the drawing. In any case the $\frac{9}{16}$ in. diameter ports on the engine don't tally with the $\frac{1}{2}$ in. diameter shown on the carburettor drawing. The engine then idled for a couple of minutes and then stalled, due to oil The jet was only open about $\frac{1}{4}$ in. turn, so it wasn't coming in there. To find a cure I drilled six No. 70 holes through the bottom ring groove, and also machined a groove about 0.015 in. × 0.015 in. deep near the lower end of the skirt and drilled that the same as the above.

As you know, these grooves are cut on close fitting plunger pumps as used in the oil pump on this engine, and in the fuel equipment of heavy oil engines, where no gland can be fitted, to act as pressure breakers and prevent leaks. In engines too small to fit rings, this grooving may help to solve oiling problems.

One of the problems which these small engine designers always leave to the builder to solve is leaking mains, especially with pressure-fed engines. The answer is to cut a groove just inside the outer end of the bush, and drill through into the crankcase. The path may be cut with a dental burr before inserting the bush.

Using an "Electrix" unit as a cooling fan, my engine has now idled smoothly for twenty minutes continuously without signs of labouring. Although the plug is not bone dry, the piston is now showing signs of the smoky deposit that is the normal growth in a working engine.

Yours faithfully,
East Ham. A. E. CLAUSON. G.I.MECH.E.

[The experiences described by Mr. Clauson with regard to oil control difficulties are of great interest, but it may be noted that in many "Kittiwake" engines, both in 15 c.c. and 30 c.c. sizes, no oiling trouble whatever has been encountered. Undoubtedly, many details of construction and adjustment, also the choice of lubricating oil, affect this issue, but the provision of scraper grooves on the piston is a well-known precaution against over-oiling, and can be recommended to anyone who encounters this trouble.—ED., "M.E."].

THE ETHICS OF KEY CUTTING

DEAR SIR,—Mr. Keller (17/9/53) is of course entitled to his opinion, but seems to have mistaken THE MODEL ENGINEER for a trade journal. There are other ways of opening a cylinder lock than that so well described by Mr. Capps, but Mr. Capps was not writing for ironmongers, even those so fortunate as to possess a *proper* machine, as Mr. Keller calls it. He was describing one quite satisfactory way, in which the amateur craftsman might disembowel a cylinder lock and fit a key to it, and made no claim that his was the best, the quickest or the neatest way. There was indeed, no reason why he should, for one might hazard a guess that one or two per cent. of all readers of THE MODEL ENGINEER would once or twice in their lives make use of Mr. Capps's article, which would wholly justify its publication.

As for Mr. Keller's sneers about a "real" ironmonger (are any ironmongers unreal ?) and a "proper" machine, and his suggestion that locksmithing be left to those whose trade it is, a few pages after his letter is an article on making a tripod head by Mr. Keily, who puts the rhetorical question: "Surely no model engineer worthy of the name would *buy* one ?" Would Mr. Keller pursue his injunction to its logical end, and have us all stop fiddling about in our workshops and go to professionals for the models, gadgets and devices we want ? For the answer to this, see G.B.S.'s "Pygmalion."

Yours faithfully,
GROUP CAPT. G. STRUAN MARSHALL

CYLINDER LATCHES

DEAR SIR,—I was very interested in Mr. Capp's article on cylinder latches, also Mr. J. Heptonstall's letter.

Could either of these gentlemen inform me how I can make a key (master) to fit 12 cylinder latches ?

Yours faithfully,
London, S.W. W. BUSH.

SIMPLE EVAPORATION REFRIGERATORS

DEAR SIR,—Referring to your Queries reply to (R.F.M. Swindon). In the September, 1952 issue of Newnes *Practical Mechanics* appeared an article by A. R. Eades, describing the construction of a water evaporation refrigerator. This article took first prize in its section of a competition describing useful devices capable of being made with easily obtainable materials. Full instructions and particulars of materials are given, and there are dimensioned illustrations.

Yours faithfully,
Bristol. W. J. ARNOT.

TWIN SISTERS

by J. L. AUSTEN-WALTON

TALKING to a really keen locomotive builder the other day, he confided to me that some of the more exterior jobs often caused him more trouble than the meticulous inner details. Here, in a sense, one's work is in the shop window, and we know that at some time or other, critical eyes may be trying to find fault.

Being watched when at work can put quite a number of people off their stroke, although that is never the case with me. I can talk and work quite efficiently unless the job calls for extreme concentration, and then my answers to questions become either vague or cease to come at all. Altogether, I like company when at work, even a completely silent companion, and if your friend happens to be equal in skill and outlook, there is nothing better than being able to gain another view on a new problem.

The problem this week is the remaining parts of the smokebox; the problem has been mine and has been solved, so that all you have to do is to follow the drawings and instructions. The smokebox has two machined ends or rings, the front ring would best be made from an iron casting, being so much cheaper than gunmetal these days. The back ring really ought to be in gunmetal because you may have to do a small silver-soldering job on the inside flange; but of that, more later.

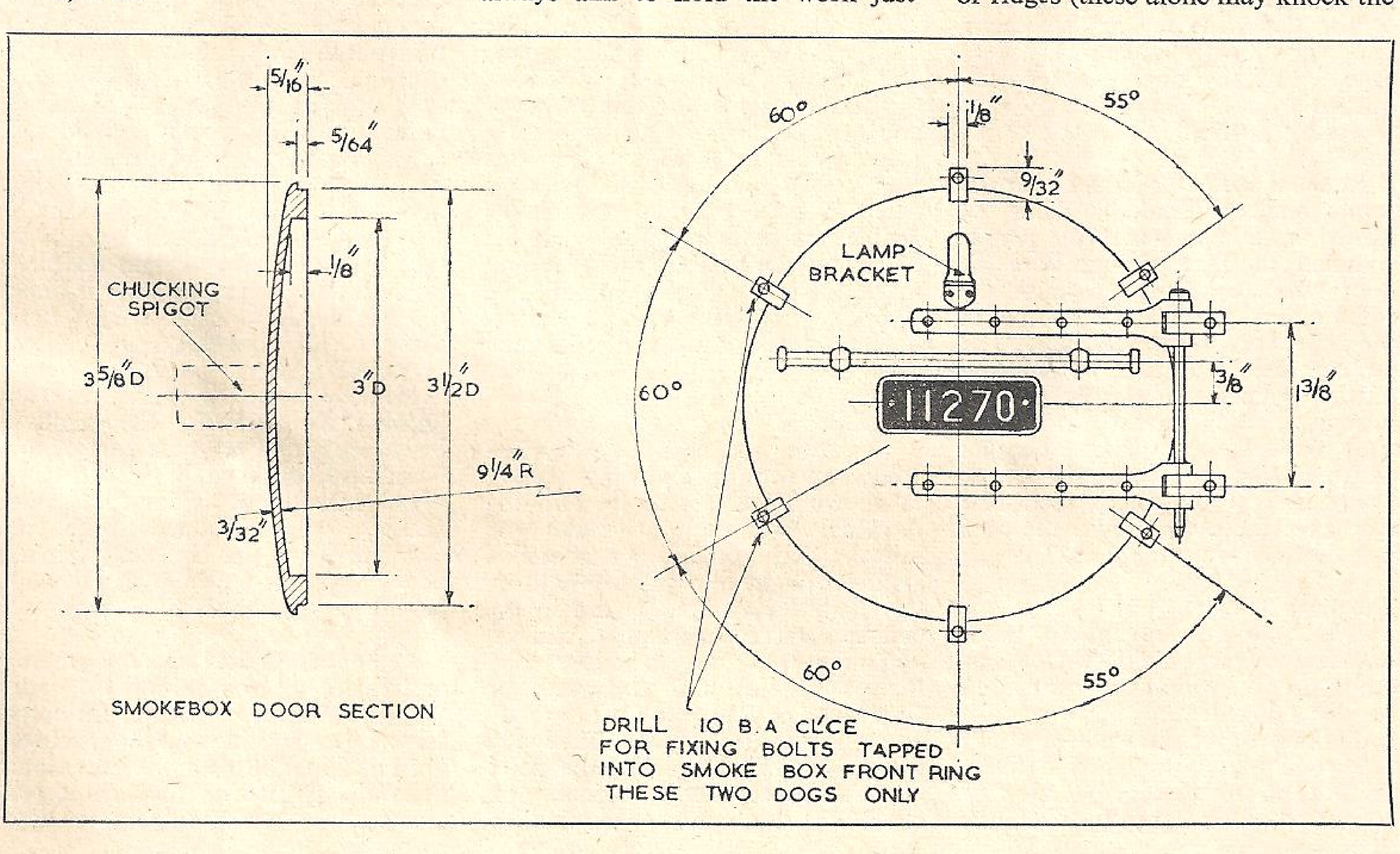
Continued from page 295, *September* 3, 1953.

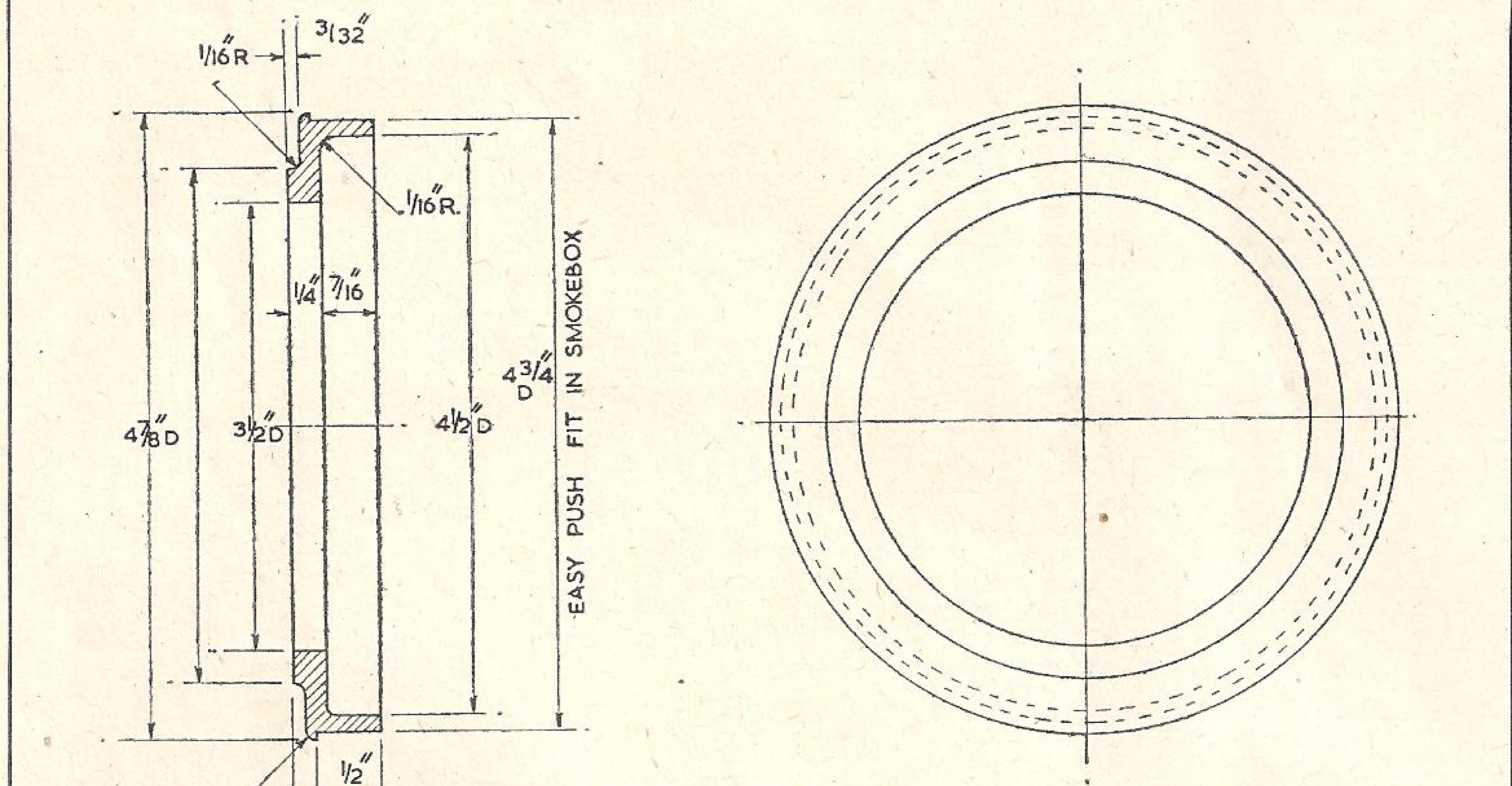
The Problem of Holding

When machining large diameter, thin section rings, the problem of holding them in a three-jaw chuck, looms large. In the case of the front ring, the section is fairly stiff and coupled with the fact that cast-iron is much more rigid than gunmetal, holding it (without excessive distortion) is not too difficult. Of course one has to use good commonsense; the modern three-jaw chuck is very powerful, and it is only too easy to mark or distort work that is slender or thin-walled. One must always aim to hold the work just tightly enough to prevent it coming out of the jaws, yet not so tightly that when it is released, the turned parts will present a triangular rather than a round condition.

Modern tools and tooling have been so developed that it is no longer necessary when machining a sandy casting, to dive straight in with a heavy cut to get under the skin of the metal, and this is just one of those things that might easily drag the tightly held job out of the chuck. The advent of the tungsten carbide tool tip, which is no longer the expensive luxury it was, enables us to take light and easy cuts on the sandiest casting that ever was, and does not glaze off or smear its point away in the first $\frac{1}{8}$ in. of travel. I notice that most enthusiasts these days, keep by them a single carbide-tipped tool for just this job alone, and have yet to meet anyone with a bad word for it. But apart from these special tips, I have also noticed that in many cases of work wrenched out of the lathe, a sly glance at the tool has shown that the operator has been trying to *push* the metal off, rather than turn it off.

For those who are not quite certain of procedure for the front ring, this is the way about it. First of all, get rid of as much sand as possible, using a wire brush over the wide surfaces, and an old file or worn out scraper for the crevices. File or chip off any main bumps or ridges (these alone may knock the





SECTION ON SMOKEBOX DOOR RING

job out of true when starting to turn) and, setting up the four-jaw chuck, hold the ring by its inside cored door seating, and with the flange outwards. Adjust the jaws to get the whole casting running as true as possible. Face the front edge, clean up the inner diameter of the flange as far as the chuck jaws will allow (for sake of neatness as much as anything), and turn the outside of the flange until it is a nice easy push-fit in the smokebox barrel.

Remove from the chuck, turn it round and, still holding from the turned *inside* diameter of the flange, complete the face turning, bore the door hole diameter, and finish the edge radius which will not be in the path of revolving chuck jaws. The job can also be turned, holding the outside diameter of the flange, but it means getting the face to revolve truly unless you can fix up a parallel packing ring to hold the work firmly against the chuck face, and still leave the outside edge radius a safe distance from the jaws.

The Back Ring

This is more difficult to hold, but there are several different ways of doing the job without any crushing or distorting taking place at all. I will not describe them all—it would take too long; but here is a fairly simple and most effective way of doing it: holding lightly in the chuck, skim out the inside to clean up. Remove from the chuck and solder a large disc of brass (fairly stout gauge) inside. Chuck from the inside, face and turn one diameter. Reverse in the chuck and machine the other end. Remove disc and clean up.

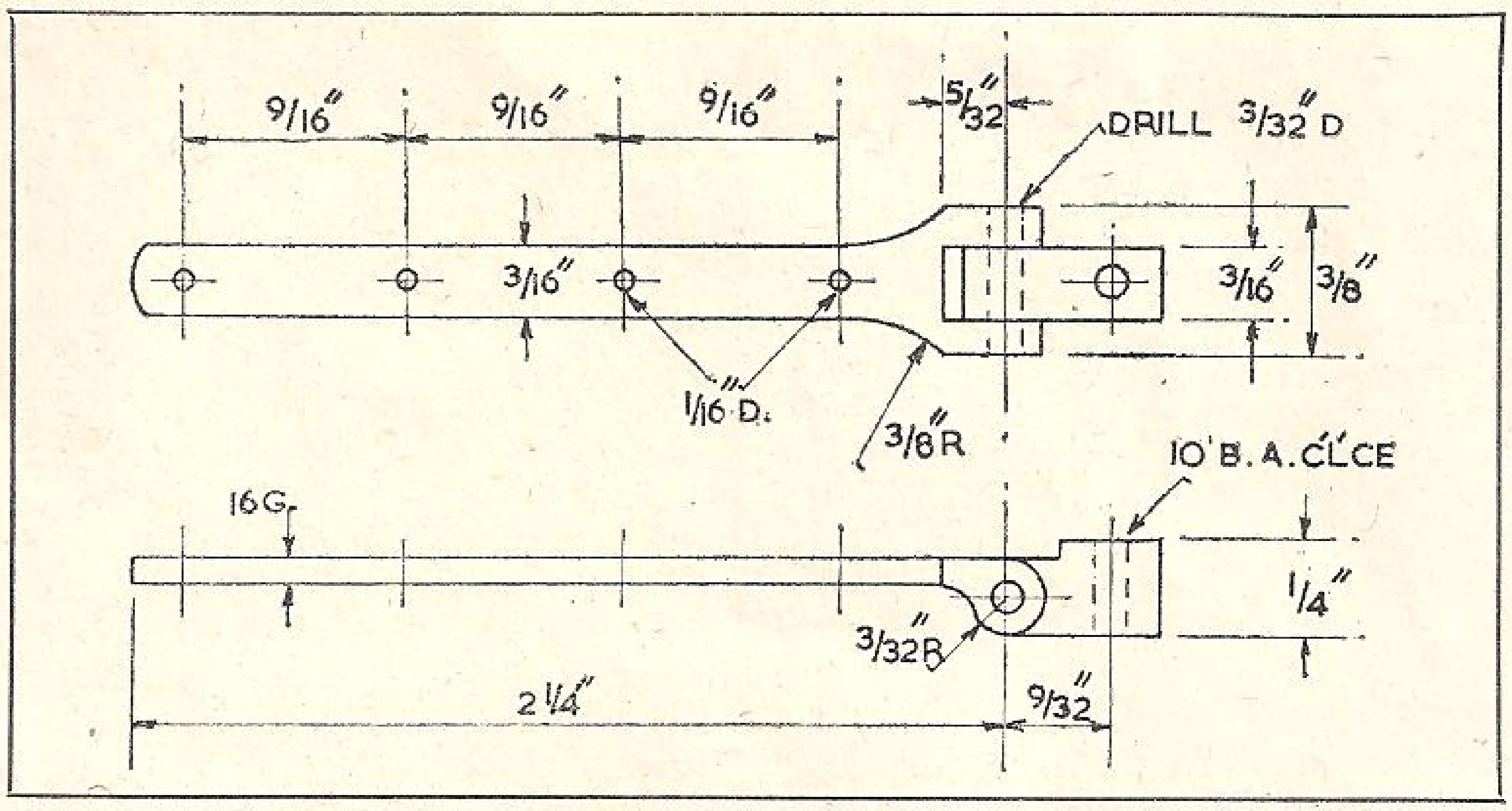
An alternative to the metal disc is to turn up a slab of *hard* wood, and knock it in—soft wood is practically useless for this diameter and wall thickness. Just one more way while I think of it; clean one face with a file, and solder it to a piece of plate brass of any shape. Drill some holes for bolting to the faceplate, position to run true and machine inside and out at one setting. Melt ring off the plate, hold in chuck and face the holding edge.

The Door

The door should be supplied complete with a chucking spigot, as shown by a dotted line on the drawing, but do not make the mistake that so many people make, sailing straight into the job held by this unmachined spigot held in the chuck. Apart from cruelty to chucks, you might want to replace the casting for some reason, and you would be very lucky to get the job held exactly as you had it before. Take the rough casting, following the sand removal procedure as before, and chuck by the outer edge, making sure it revolves reasonably true. Machine the spigot, remove from chuck and hold by the spigot, turning the back face of the door, the inside radius and, note carefully, the short parallel stepped bore inside. The inside radius is best checked as you do it, by first preparing a thin metal template, marked off from the dimensions given on the drawing. This sort of wide radius turning is a job for a wide-faced hand tool using the lathe hand-rest set across the face. Turn the door step, trying it in the front ring aperture for size, but not making it *too* tight. A good and true edge face will see to the airtight qualities required, and when the door is hung on its hinges, a tight spigot may prevent its opening or closing properly.

Remove from the chuck, reverse, holding the door by the shallow inside step, and machine part of the front face, using a thin metal template marked out as for the inside radius. This will have to be cut away to clear the chucking spigot, as we have not finished with it, and on no account must it be removed yet.

Remove from the chuck once more, and make up the set of six door "dogs," marking out the positions for these and noting that the spacings are not equal all round. This state of affairs is also on the prototype, and we are not indulging in any



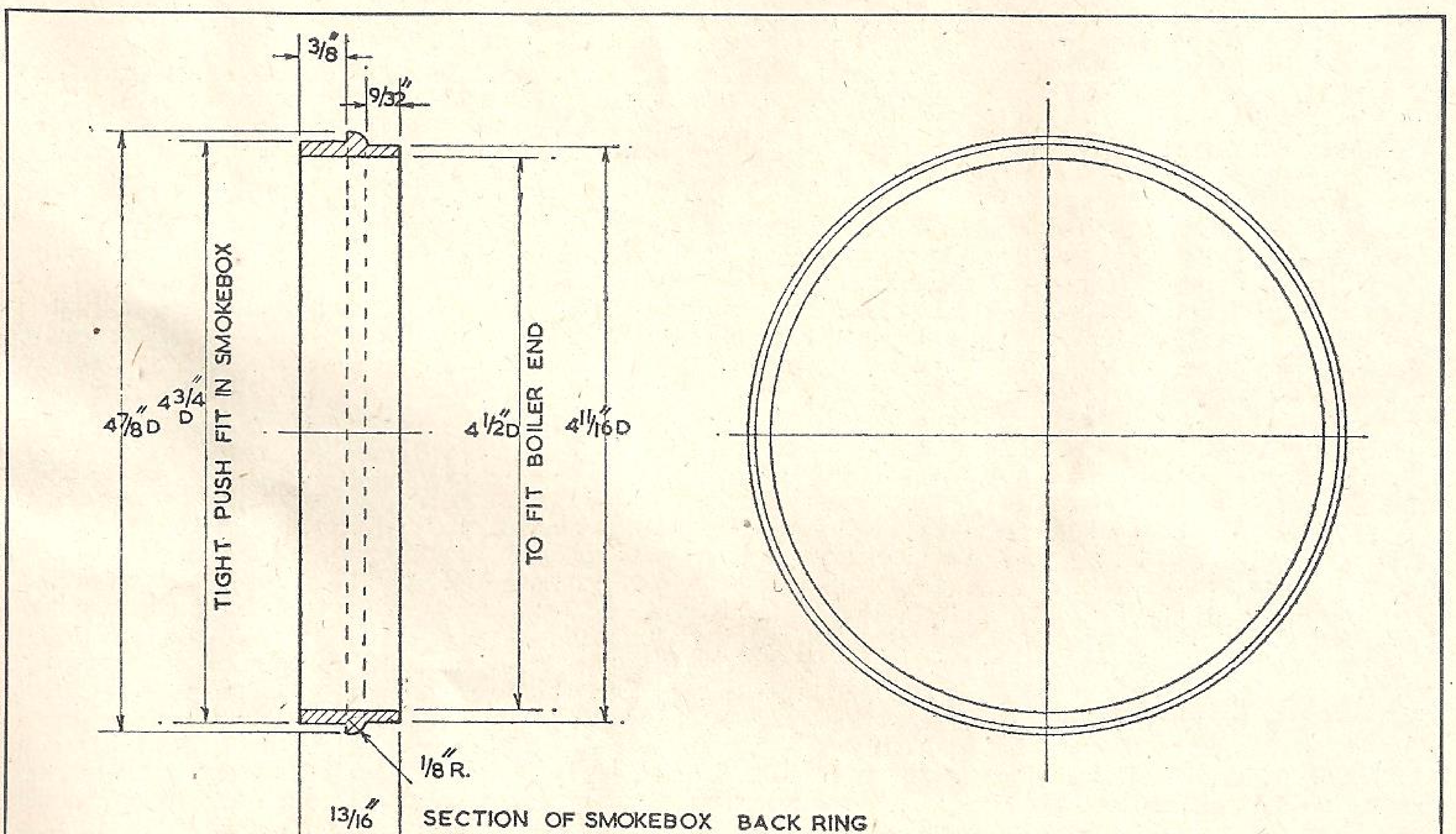
form of private cheating by so doing. When making the dogs, let them project slightly at the back, so that they may later be faced off flush with the door ledge. You may find it convenient to pin each dog in place with a fine rivet or even a bit of brass wire, as they have a way of floating about on molten flux, and there will be six of them to watch—all at once. With the silver-soldering done, chuck once more by the chucking spigot (you see what I meant when I mentioned that point) facing off the projecting parts of the dogs to lie flat with the door ledge, after which it may be removed and chucked the other way round for turning off or removing the spigot, finally facing off to match the rest of the door front, and giving it a good scouring with coarse emery-cloth. There is nothing to be ashamed of in this—the finish left will provide a good key for the paint that will follow later.

The Hinges

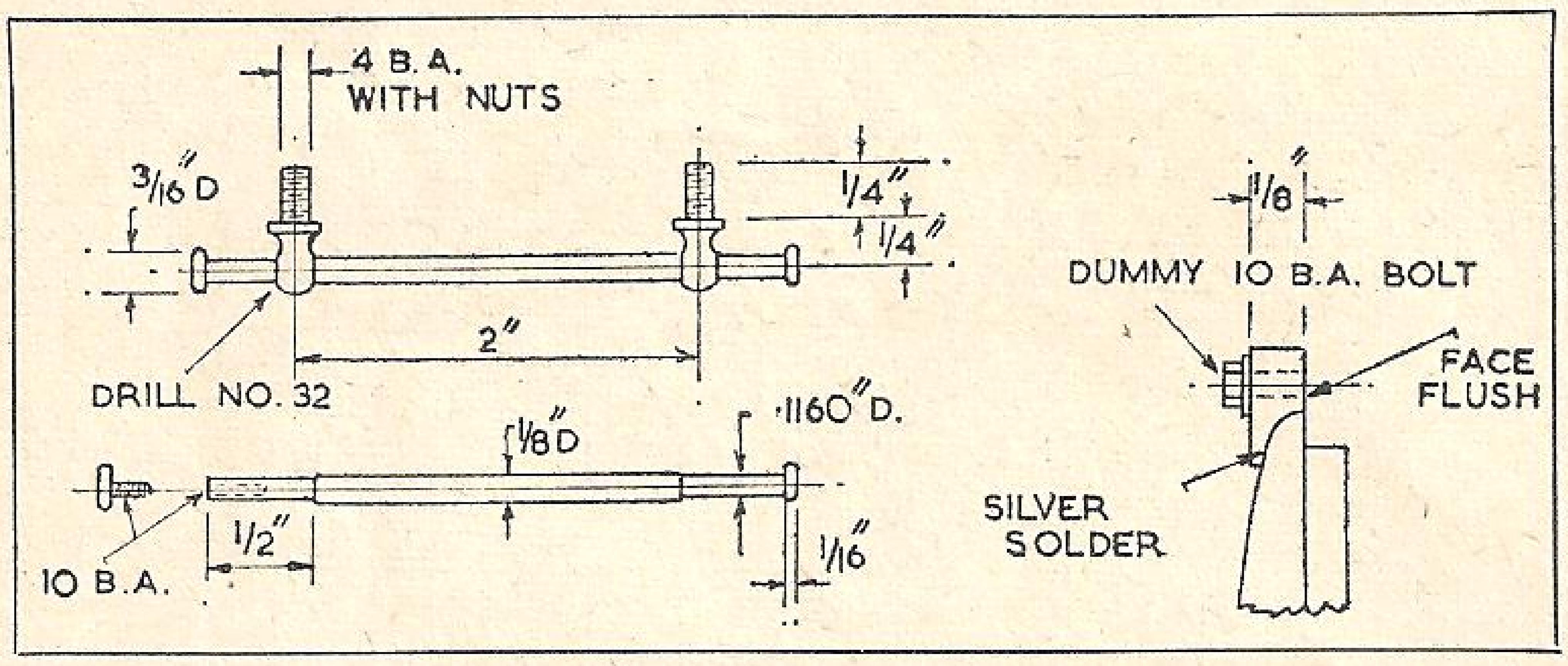
For some unknown reason, these are the little devils that always get a bad name when it comes to getting them on fair and square, and in the right position. There is really no reason for this, especially if the pintles are fixed first. Get these in position with the main hinge pin in place and the two straps left flying in the breeze. If the straps have been made up from flat strip and the bosses silver-soldered on at the end, which is the method I recommend, they will be quite soft and pliable, which is just the condition we need. Put the door in place and bend the straps over the curved door face, spreading them out if necessary, and fixing by one rivet each, out and along their length. Guide lines might be scribed to advantages on the door first. Follow on with the remaining rivets when you are sure the straps are lying flat and true, and not standing up in loops between each rivet position; the worst is now over.

Remaining Fittings

The remaining fittings comprise the lamp bracket, the front handrail, and the engine number-plate. The lamp bracket calls for no comment, except that it has the normal step at the bottom for the lamp to rest on. The front handrail is as shown on the drawing, and it will be noted that the end buttons are separate and screwed into the rail ends. These are not absolutely necessary but certainly make a whale of a difference to the general looks at the front end. They are authentic, too. Making the rail ends slightly smaller where they go through the rail knobs, is a wheeze of my own (I think) and avoids the fiddling job of drilling for tiny through pegs to key the rail in position. Not



SECTION OF SMOKEBOX BACK RING



only that, at any time you wish to remove the rail for cleaning, painting or repairs, a couple of nuts removed from inside, and the whole issue takes to pieces in a few seconds. Whilst on the subject, remember to spot-face the door front for seating the rail knobs at the front, and doing the same at the back will ensure the nuts having a reasonable seating; but do not overdo it—the door wall is not very thick.

A Problem

The engine number-plate is always a bit of a problem, even if it is cast in brass (which is the ideal). The work of making the pattern for this is quite as much as making the finished job from the solid, except that two plates will ultimately be required—one going on the bunker

The full size number-plate in reverse

back. If you like the fiddling type of job, there is always that of cutting the numerals out of thin brass and soldering them on to a backplate. My plates were done by photo-etching, taken from a large drawing I made for the job, and I have asked our editor to reproduce here in full size, the actual photograph (taken in reverse) that was used. This method is hardly the cheapest, but undoubtedly the best. If you wish to avail yourselves of the method, all you have to do is to trace this plate with its numbers, ink it all in very carefully and send it off to your local newspaper or printer who will get the necessary blocks made for you.

When these come to hand, all you will need to do is to trim the outside edge carefully, black in the background with enamel and shine up the border and numbers by rubbing the plates on very fine emery-cloth, laid on a flat surface. The type metal, being of a zinc base would soon discolour if not protected, so I advise a thin coat of clear lacquer over the lot. Incidentally, when ordering, say that you require the blocks unmounted—this will save a little expense.

Door Fixing

The method of fixing the door is one that I devised for speed and neatness. You will see that all the "dogs" are captive, which is a great convenience without spoiled appearances. Two of the dogs, shown on the drawings, have clearance holes for 10-B.A. studs drilled in them; the other four are fitted with dummy studs which need never be disturbed. When the door is finally fitted, drill a couple of tapping-size holes in the smokebox front ring into which the working studs will go. Believe it or not, it takes but a few seconds to remove these if ever you want to peer inside in a hurry.

As for the finish, the whole lot should be dull black with the exception of the hinge-pin, and I suggest, the heads of all the 10-B.A. studs. A spanner soon knocks the enamel off things like nuts and bolt heads, and as you will have to remove the two fixing studs from time to time, you do not want to draw too much attention to two out of six bolt heads. From time to time we hear comments on smokebox temperatures, and what it does to the paint. I have never suffered in this direction, and the smokebox of *Centaur* still bears its original paint—without a blemish of any kind. I believe in building my boilers to use up the generated heat in the firetubes and other heating surfaces, and this can only be done by calculating the correct tube areas and the disposition of such things as superheater tunnels. Excessive superheating area is one of the main causes of nearly incandescent smokeboxes, and this is a very unnecessary fault.

Next on the list is the description of the dome and safety-valve casing. These are not very big items, so we will try to squeeze in details of the running-boards. Several people have written in for these, just because they want to see what the locomotive looks like with them in place. Heigh Ho !—I used to be like that myself some years ago !

(To be continued)

CATALOGUES RECEIVED

We have received copies of the latest catalogues to be issued by Kennion Bros. (Hertford) Ltd. The first of these consists of 34 pages, and costs 9d., which is refunded on the first £1 order. It gives particulars and prices of blueprints, castings and parts for live-steam locomotives from 5 in. gauge to "O" gauge, including most of "L.B.S.C.'s" ever-popular range. We like the new idea of allotting a page to each engine, each headed by a reduced reproduction of the general arrangement drawing; this is an instantaneous aid to identification and will be welcomed by enthusiasts everywhere, but especially overseas where the various engines illustrated are not so familiar to patrons as they are to us in Great Britain.

The list also covers the Kennion mill engine and a wide variety of useful fittings, wheels and a passenger-carrying truck. A few reproductions of prototype locomotive photographs are also included.

The second catalogue, of sixteen pages, deals with tools and materials, including the well-known Kennion taps and dies, boring bars, tap wrenches and other small-tool specialities, and several new lines feature in this catalogue. We have recently had an opportunity of trying out a set of form reamers specially made for machining the tapers and flares of "L.B.S.C.'s" injectors, also cutters for spot-facing and counter-boring, all of which conform to the same high standard of quality in relation to cost. A wide range of materials, including steel, brass, copper, etc., in sheet, tube, rod and various sections; screws, bolts and nuts, and other model engineering requisites are also listed.

Talking about Steam—

NO. 21.—EIGHTY YEARS OLD!

By W. J. HUGHES

THE working life of a traction-engine or road locomotive has often extended to fifty or sixty, or even more years, as is well known, and in fact there are quite a number of engines in this country, over half-a-century old, still capable of working. However, in the United States there is an Aveling and Porter general-purpose traction-engine still in existence, which was built *eighty* years ago, and is still steamed from time to time.

For the photographs which accompany this article, and for much of the information on which it is based, I am indebted to F. Hal Higgins, of Oakland, California. This gentleman's knowledge of agricultural practice and machinery, especially of the steam variety, is tremendous, and his collection of documents, photographs, books, catalogues, and so on, must be one of the most extensive in existence anywhere in the world, at least in private hands. His enthusiasm is equally great, as is his thirst for further knowledge, and he is in contact with like-minded people in many places, of whom I count myself honoured to be one.

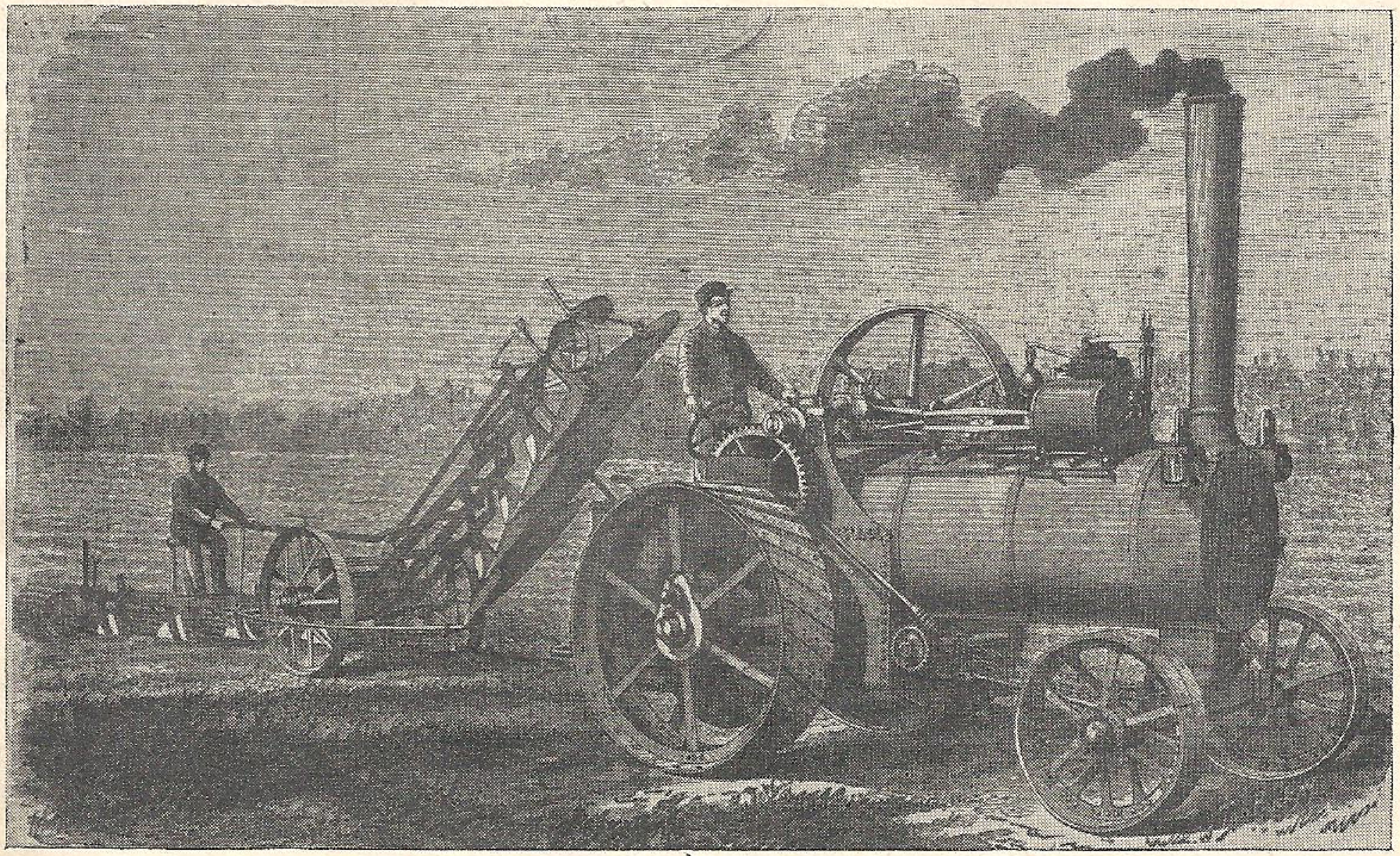
Earning the Dollars

In the sixties and seventies, British traction-engines were being exported to divers countries, by Fowler, Aveling and Porter, Burrell, Ransomes, Clayton and Shuttleworth, and other firms. In January, 1870, the U.S. Congress, under pressure from landowners and agriculturists, lifted their import duties on these engines, and British manufacturers were not slow to take advantage of the fact, by exporting more engines than before.

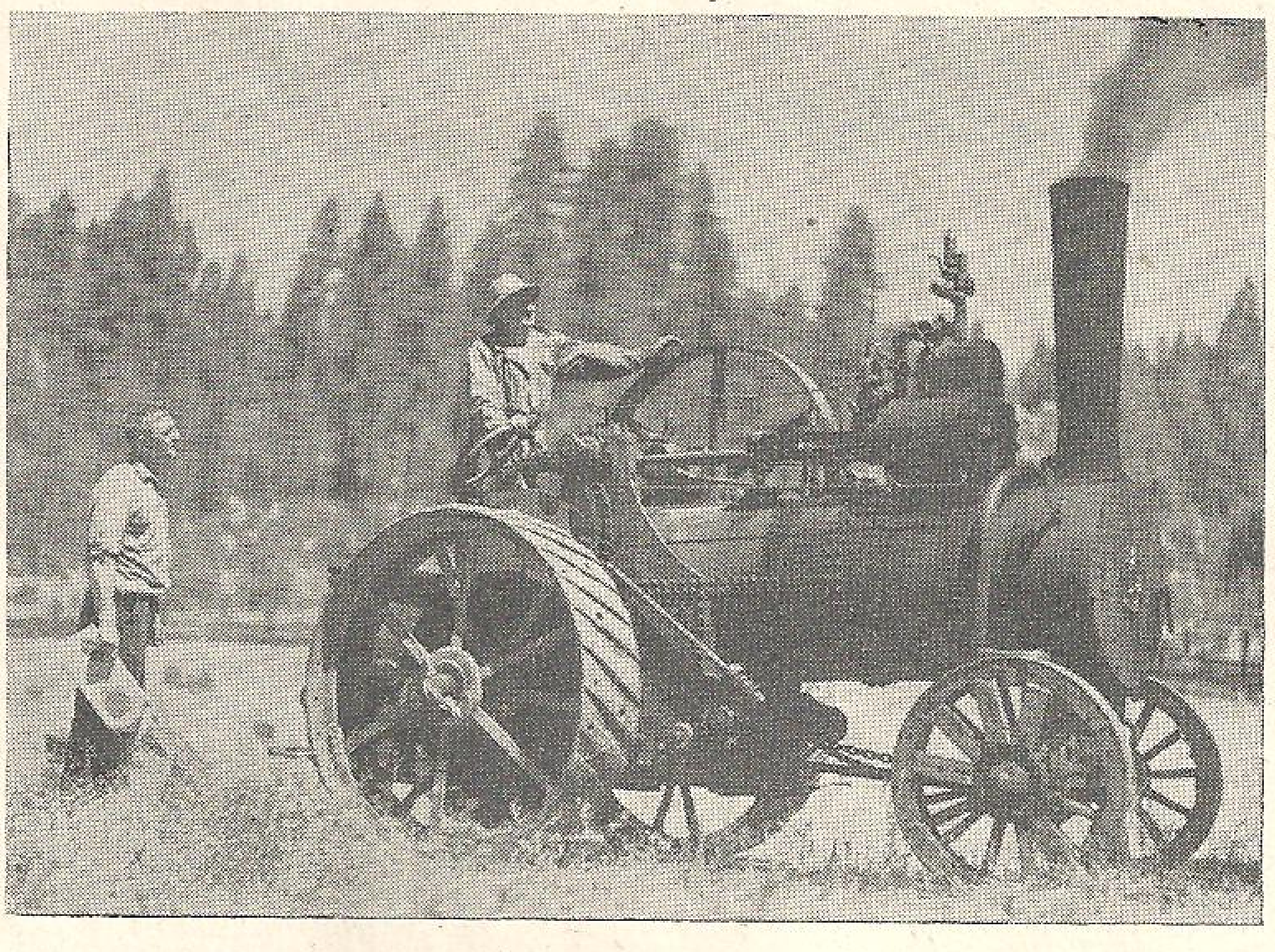
The first illustration is reproduced from the "Pacific Rural Press," published in San Francisco on Saturday, January 3rd, 1874. The caption to the engraving is "Aveling and Porter's road locomotives, adapted to direct traction steam plowing." As will be seen, the engine is hauling a four-furrow balance plough, and, of course, at the other end of the field the engine would be turned round, to haul the plough in the other direction, with the other set of shares now doing the work.

The accompanying text says that the "large cost of the English rope system of Steam Plowing Machinery seems almost to preclude its general adoption in America," but goes on to quote Aveling's claim that "with an engine weighing not more than five tons, and this weight carried on broad wheels such as the engraving illustrates, from six to ten acres per day... can be plowed with a four-furrow plow."

Aveling's also stated that the



Reprint from the "Pacific Rural Press" of January 3rd., 1874, showing an Aveling and Porter 6 n.h.p. engine "adapted to direct traction steam plowing"



Owner Lloyd Burr on the footplate of the eighty-year old Aveling, while Clayton Phillips looks on

engine was more than powerful enough to drive the largest size threshing machine, and that it could easily haul fifteen tons along moderate roads and up steep inclines. Examples are quoted from New Jersey to Ohio of Aveling engines being used for such diverse uses as hauling broken stone for road making, drawing logs out of the woods, threshing grain, and hauling twelve to fifteen tons of pork in the streets of Cincinnatti.

A later issue of the same journal, dated August 22nd, 1874, mentions that the Aveling engines were of twelve horse-power (American rating), with a steam-jacketed cylinder of eight by ten inches (i.e., *six* nominal horse-power by British standards—W.J.H.), and a lagged and felted boiler with 120 feet of heating surface. "The entire cost per day of running the engine, including fuel, labor, oil, etc., does not exceed six dollars, and when hauling, the rate of speed per hour can be continued at three miles."

New York Importer

It is stated that the total cost in New York of a complete farm locomotive, four-furrow plough, and all appliances ready for work did not exceed $3,600 gold, the engine without the plough costing considerably less.

Aveling and Porter's representative in America was William Churchill Oastler, of New York, and he imported quite a number of engines, including road rollers. Two of these, incidentally, supplied in 1869 to Prospect Park, Brooklyn, and to Central Park, New York, were the first steam rollers in America. They were of similar design to the original Aveling roller of 1867, weighing nearly 30 tons, with a single-acting single cylinder of 11-in. bore and 14-in. stroke. (I hope to describe, illustrate, and give drawings of this design in a later article in this series; it would make a most interesting and unusual model.) Another roller was supplied later to the West Point Military Academy.

Reverting to the traction-engines, most of these were of the design already shown in the first illustration, and among them was No. 916, which forms the subject of the remaining illustrations. It was built in 1873, to the design first introduced by Thomas Aveling at the Oxford Show of the Royal Agricultural Society in 1870. This was his first gear-driven design, with a single speed, and incorporated the celebrated "hornplate" invention, in which the shafts were carried in bearings mounted in the upward- and backward-extended firebox sides, instead of in cast-iron brackets as formerly used.

As mentioned in a previous article, this was a notable advance in traction-engine design, which was soon widely copied or adapted by other makers until its use became almost universal.

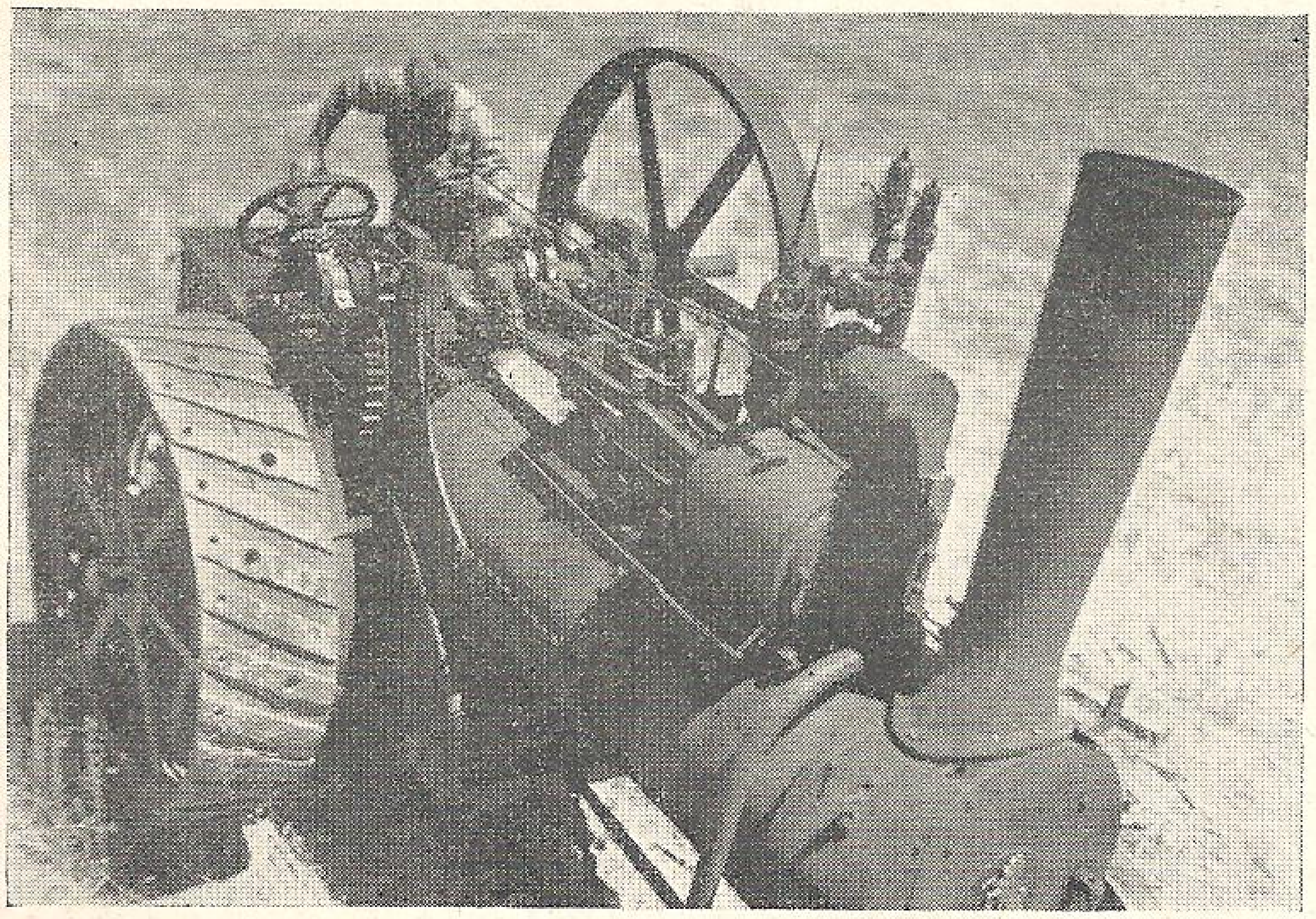
From the Builders' Records

Messrs. Aveling-Barford still have the records of engine No. 916, and

In this view, points to note are the wooden fore-carriage, method of hinging and fastening the smokebox door, and steam-pipe arrangements

these give the following particulars. The hind wheels are 5 ft. 6 in. in diameter and 16 in. wide; the front wheels are of wood, 3 ft. by 5 in. Cylinder is 8 in. by 10 in., with a direct-acting governor (more of this anon) and a double steam dome. The fore-carriage is wood, with a wooden tool-box in front. Perch-bracket, turntable, and through-pin are wrought-iron.

Spur-wheel gearing is fitted, with a wrought-iron guard; there is no compensating-gear, but the brake is "improved," with wood segments. Hind-axle bearings are white-metal in cast-iron brackets; the second-shaft brackets are gunmetal on the driving side and cast-iron on the flywheel side. To the latter was bolted the water-pump, which was fitted with a $1\frac{3}{4}$ in. diameter plunger. The chimney was wrought-iron with a cast-iron base.



Points of interest here are single safety-valve (in line with steam-pipe), two whistles, regulator arrangement, remains of Pickering governor, main bearings, and clamp on crankshaft.

Present Owner

It is not known to whom the engine was sold by Mr. Oastler, nor through whose hands she subsequently passed, but she was found a few years ago in the backwoods of California by Mr. Lloyd Burr, a professional engineer. She had been driving a saw-bench for many years, but would undoubtedly have been scrapped before long. Mr. Burr promptly bought her for preservation, to keep company with his huge 110 h.p. Best logging engine of 1906.

Both engines are being kept at the Phillips Brothers saw-mill in the Sacramento Valley, California. Incidentally, these four brothers are themselves keen steam enthusiasts, and run the mill with nothing but steam-engines rescued from old mills in the "logged-off" areas of the valley. They themselves possess at least two of the Best giants.

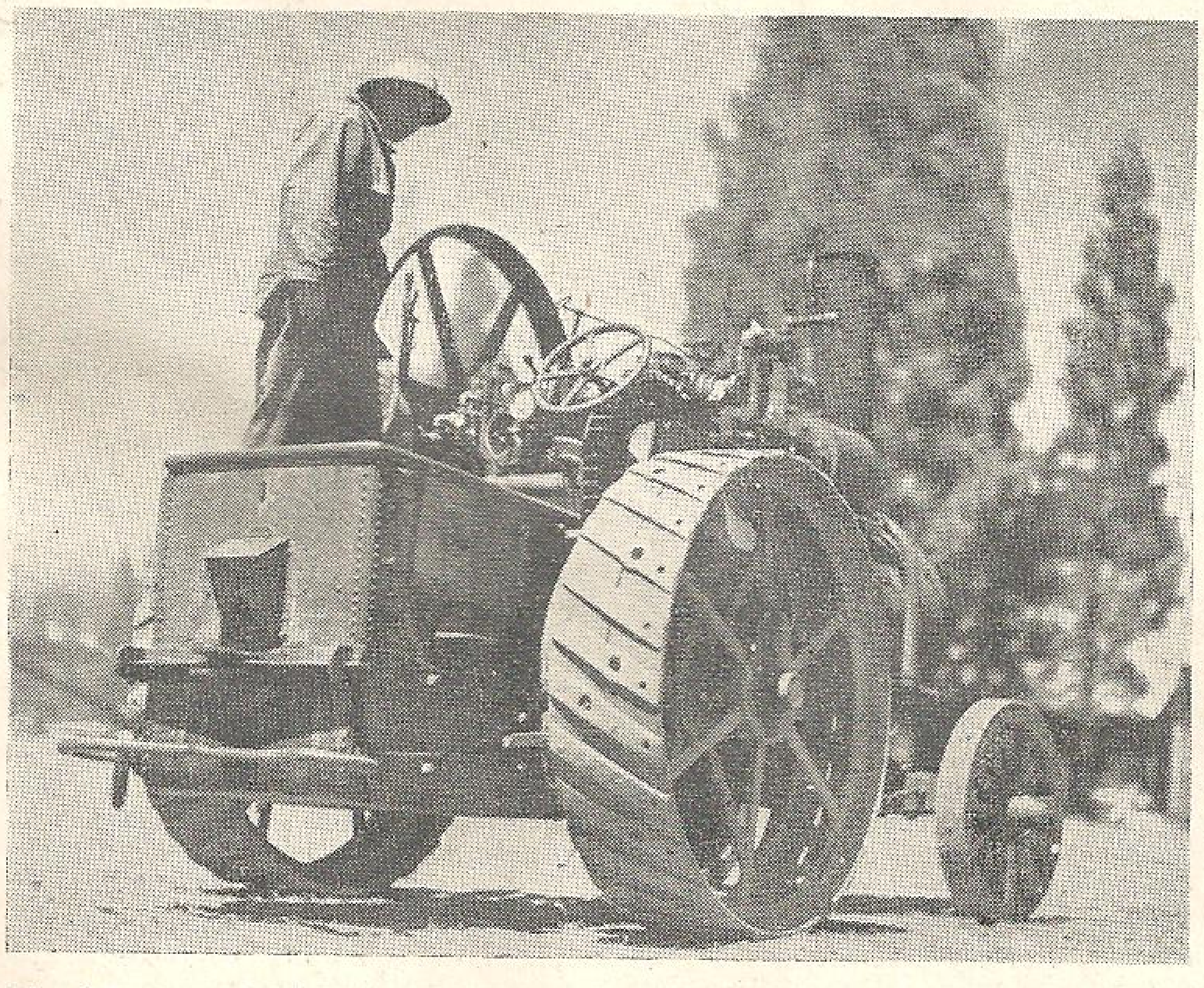
Mr. Burr intends to restore the old Aveling to her original condition, as imported, as far as possible, but this will be a difficult task, it is feared, after all the intervening years. If the reader compares the photographs with the engraving, he will notice that one or two major alterations have been made.

For example, the steam connections have been considerably altered. In the original, steam passed from one compartment, over which double Salter-type safety-valves were fitted, direct to the regulator-valve, and a slow-speed Watt-type governor controlled the engine speed.

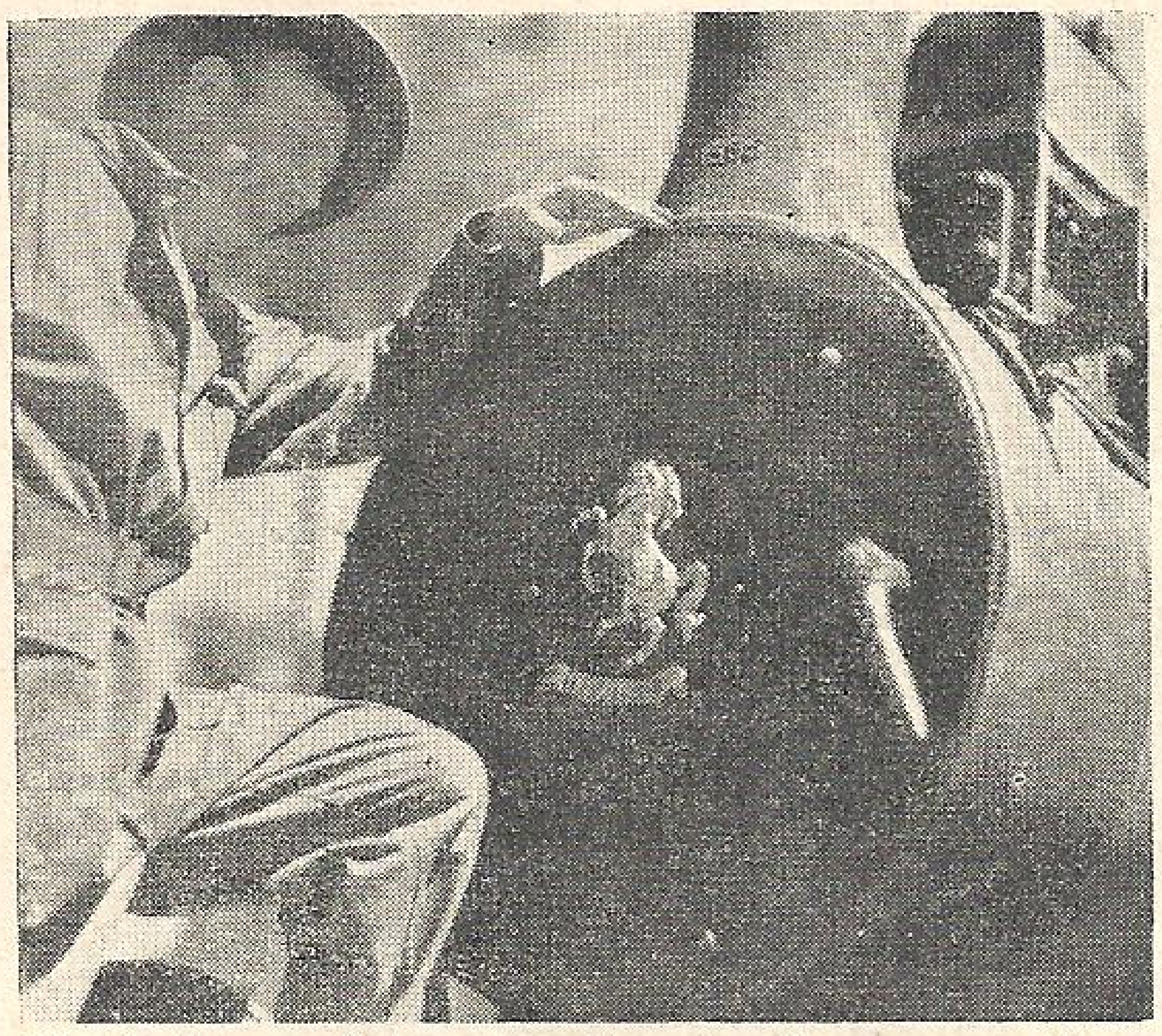
But in the "improved" version, a single enclosed safety-valve is mounted on top of the dome, and a complicated and unsightly arrangement of pipes and elbows takes the steam from the dome, via a screw-down valve and swivel regulator-valve to an external Pickering governor, from which a further elbow and pipe takes the steam to the front of the valve-chest. An alteration of the exhaust arrangements is also evident.

Boiler lagging is now non-existent, and the chimney is not the original (as may well be expected !). It does have a distinct Aveling appearance, but the original had a cast-iron base only (with rectangular, not oval, flange), and was taller and more slender.

The front wheels, too, are probably replacements. In any case, they have been well "botched-up," and are very weak and wobbly after standing out in mud on a long pumping job. Mr. Burr intends to rebuild them, however, in seasoned oak and hickory—in fact,



Lloyd Burr on the footplate. Note water-filling pocket, construction of standard draw-bar, and special draw-bar beneath for steam-ploughing



Lloyd Burr admires his "modern" rampant horse insignia, which he removes after each run to prevent its disappearance !

they will probably be done by now.

Strictly speaking, the "rampant horse" insignia is out of keeping too, being the heraldic version adopted by Aveling's in 1935, after seventy years of the older version. But when Mr. Burr acquired the engine, the old insignia was missing, and he obtained the new one from Messrs. Aveling-Barford direct.

One other difference may be noted. On the original, the driving pinion on the crankshaft was held in or out of gear by means of a leather strap which was buckled round the shaft. On No. 916 this has been replaced by a steel clamp, which may be seen between the pinion and the collar at the end of the shaft.

Similar Engine in Britain

It will probably be news to many readers that an Aveling engine of this period is being preserved in Britain. It was presented to the Road Locomotive Society by the late P. J. Hoseason, and for some time was kept at Maidstone in Kent. Recently, however, it was presented by the society to the Science Museum, and I understand that after being thoroughly reconditioned—which will probably take some time—it will take its place in the Road Transport section there.

Another historical exhibit of a similar nature is now in the City of Birmingham Museum. It is an Aveling and Porter roller of a rather later date; and this, too, has been overhauled, rebuilt, and repainted until it is probably better than new. I have not seen it myself yet, but at the recent "M.E." Exhibition, Mr. A. J. Kent was kind enough to show me some photographs which certainly whetted my appetite. The museum authorities are to be congratulated on their foresight in securing this engine, and on their enterprise in having such a magnificent job made of her reconditioning.

FOR THE BOOKSHELF

Switzerland's Amazing Railways, by C. J. Allen. (Edinburgh: Thomas Nelson & Sons Ltd.). 180 pages, size $6\frac{1}{4}$ in. by $9\frac{1}{4}$ in. 47 art-paper inserts for numerous illustrations. Price 25s. net.

Mr. Cecil J. Allen needs no introduction to readers of railway literature; his many books and thousands of articles are known wherever the English language is understood, and it can be no exaggeration to claim that he is one of the most widely read of authors in his particular field. But here is a book that, in many ways, is different from any previous book from his prolific pen.

Switzerland's network of railways is comparatively young, and because of the unique and often daring nature of the engineering skill, ingenuity and enterprise involved in the planning, construction and operation of the railway system, quite apart from the spectacular nature of the terrain, it is an ideal subject for an author gifted with the power of adequate descriptive writing; and Mr. Allen has risen nobly to the task of presenting his readers with an engrossing historical and factual record of what is probably for its size the most remarkable railway organisation in the world.

The text is lucid to a degree, easy and frequently entertaining to read, and at the same time avoids purely technical and statistical information, except when it is absolutely necessary. Even without the aid of illustrations the reader can visualise most of the engineering and technical problems that had to be overcome, and can appreciate the special features that are inherent to the railways as they are.

But the illustrations included in this book, and there are nearly two hundred of them, are superb; some of them are of almost breath-taking beauty, and all of them point directly to the engineering achievement that the railways themselves immortalise. This is a book that should not be missed by railway enthusiasts anywhere.

Diesel Locomotives. (London: "The Times Weekly Review"). 20 pages, size $8\frac{1}{2}$ in. by $5\frac{3}{4}$ in. Price 1s.

We have received a copy of this booklet which contains brief particulars and ten photographs of British diesel locomotives, diesel railcars and the first gas-turbine locomotive to run on British Railways. The subject is well covered in the brief text, and most of the illustrations show the locomotives at work. Copies may be obtained from "The Times Weekly Review," Printing House Square, London, E.C.4.

The World's Great Bridges, by H. Shirley Smith. (London: Phoenix House Ltd.). 180 pages, size $5\frac{1}{2}$ in. by $8\frac{1}{2}$ in. Price 15s. net.

Of all the great engineering structures fabricated by man, none is more impressive than a massive bridge. There can be little doubt that in bridges the engineer has displayed his greatest ingenuity, audaciousness and courage, and no thinking person can fail to realise this and be duly impressed with the idea when looking at a bridge.

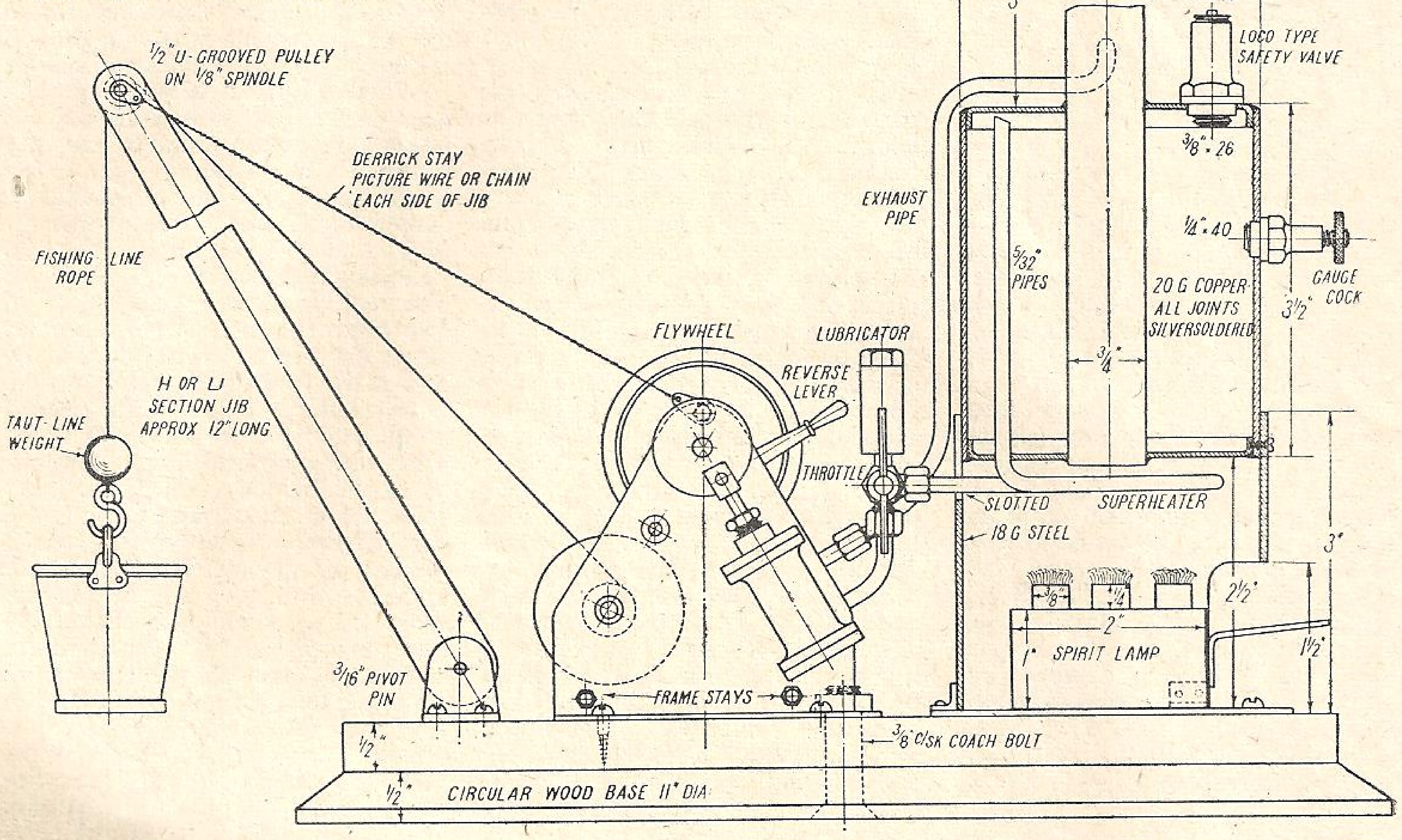
This new book by one who is, perhaps, the greatest designer of bridges in our time, relates the story of bridge-building from the earliest times. The historical account is extremely interesting and leads into descriptions of the great bridges that have since been built in various parts of the world.

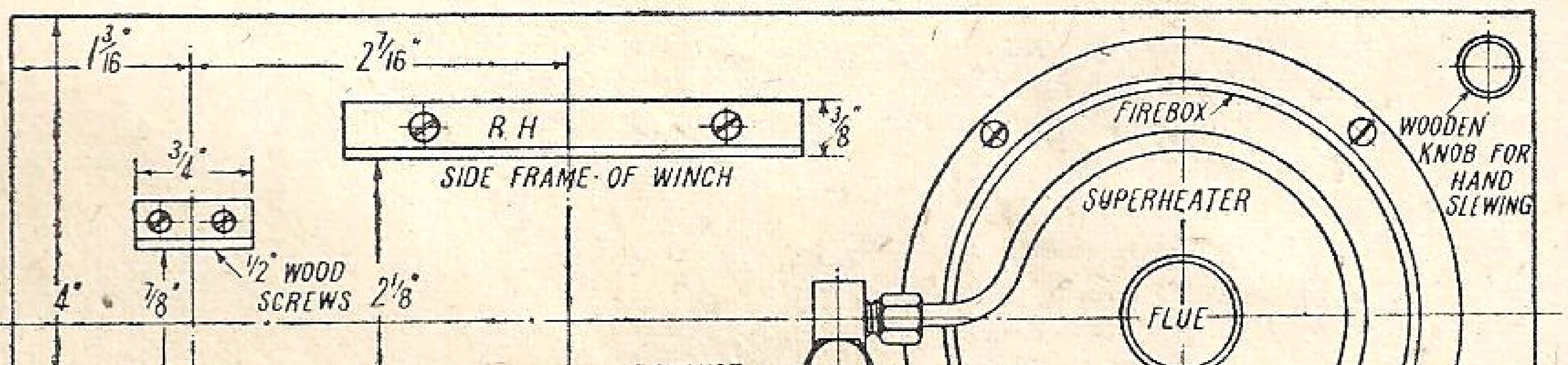
There are forty-three half-tone illustrations and twenty-four line drawings by R. J. Mainstone. The final pages are devoted to a useful and comprehensive index. The book bids fair to become the most important non-technical treatise in its subject.

L.B.S.C.'s CHRISTMAS PRESENT FOR THE KIDDIES

A SIMPLE STEAM CRANE

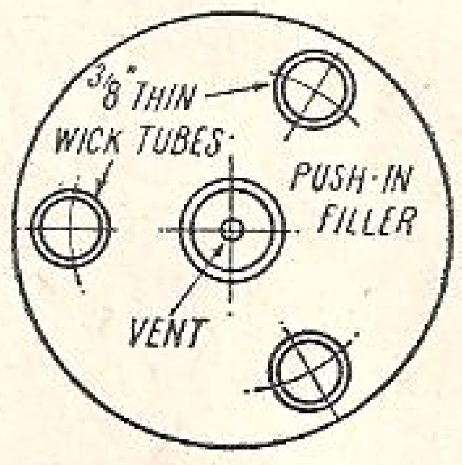
ONCE again, I have received sundry exhortations to put something in for the kiddies' Christmas present, soon enough for it to be finished by the time Santa Claus is ready to deliver; so here is the needful. This year the suggestion is for a little steam crane, which can be operated from the table or the window-sill. It is cut to the rock-bottom of simplicity, for reasons of cost, ease and speed of construction, and to enable it to be operated by any kiddy who can strike a match without risking burnt fingers. The crane is of the stationary type, as used on wharves, loading docks, etc., before the advent of the i.c. mobile crane; but it can be slewed by hand on its baseboard. To simplify the driving, neither clutch nor brake gear is fitted, crankshaft and winch drum being permanently connected. Only two handles are needed, throttle and reverse lever; so all that the young crane driver has to do, is to move the reverse lever either up or down, according to whether he wants to lift or lower, and give her steam. There is, of course, no objection to anybody adding refinements if they so desire.





General arrangement and part plan for a simple steam crane

The boiler is of the single-flue vertical type, with no water-space around the firebox. It is made from thin copper, with silver-soldered joints, and will come to no harm if the kiddies run it dry. The firebox is just a piece of sheet metal bent to a circle, and the firing is by a spirit-lamp. The boiler fittings are only what will be absolutely necessary. The motive power is a double-action oscillating cylinder, with a reversing-valve on the back; steam is regulated by a screwdown valve with a lubricator fitted integral. The cylinder is mounted on a



Plan of burners

triangular frame carrying the gears and winding drum. The jib, made from channel or H-section metal, is pivoted at the bottom, and stayed by guy wires attached to the stay at the top of the winch frame. Hand derricking could easily be arranged, but it isn't necessary in the present case. The cylinder and winding drum can be made from castings, or built up; gear wheels from a broken clock or gramophone, will do just as well as the most expensive kind that could be bought or made. There is no need to keep exactly to the wheel sizes given, as the distance between centres of the shafts, can be varied to suit whatever wheels may be available. Very little detailed description is needed, the drawings being self-explanatory, so I won't inflict a long-drawn-out rigmarole on prospective builders!

Baseboard and Boiler

The whole doings is erected on a circular baseboard about $\frac{1}{2}$ in. thick, and 11 in. diameter; a turned and bevelled hardwood one would look very pretty, but isn't essential. Drill a $\frac{3}{8}$-in. hole in the middle, and countersink it underneath. The crane baseboard, measuring 4 in. × 10 in. × $\frac{1}{2}$ in. thick, also has a hole in the middle; and a $\frac{3}{8}$-in. countersunk coachbolt goes through the lot, the nut and washer being adjusted so that the upper board can turn on the lower, without slackness. A thin circular metal plate 4 in. diameter, could be put between the two rubbing faces if desired. Screw a small wooden drawer-knob in one corner, for the kiddy to grab when slewing the load.

The boiler shell, $3\frac{1}{2}$ in. high and 3 in. diameter, can be made from 20-gauge copper tube, or rolled up from sheet copper of similar gauge, and riveted. The ends are flanged, and are a tight push fit. Each has a $\frac{5}{8}$-in. hole in the middle, to accommodate the flue, which is of $\frac{5}{8}$ in. × 20-gauge copper tube, fitted as shown. Two bushes are needed, for safety-valve and test cock. The combined steam-pipe and superheater is bent up from 5/32-in. copper tube, and poked through a hole in the bottom plate. Fit a $\frac{1}{4}$-in. × 40 union nut and cone on the projecting end, as shown. The whole bag of tricks can be silver-soldered at one heating.

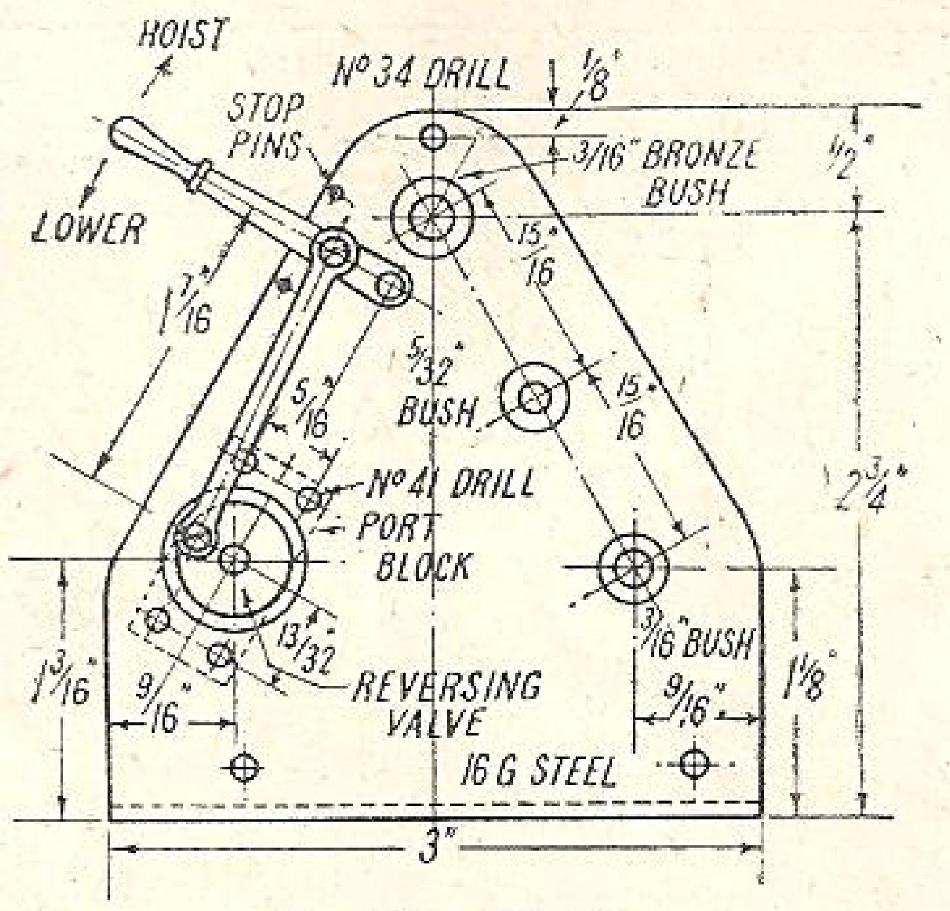
The firebox is rolled-up from 18-gauge steel, and has a 2 in. gap cut in it to allow the lamp to be inserted. It is attached to the boiler by brass screws put through the flange as shown, which gives plenty of hold for the threads; a smear of plumbers' jointing on them, will prevent any leakage. The baseplate is a circle of 18-gauge steel, $3\frac{3}{4}$ in. diameter. The firebox is attached to it by three pieces of $\frac{1}{4}$-in. × $\frac{1}{16}$-in. angle, riveted on. The baseplate is attached to the baseboard by four woodscrews, as shown in plan. The test cock—which isn't really a cock at all—is exactly the same as a water-gauge blowdown; and the safety-valve is of the regular locomotive-type pattern, with a 5/32-in. ball on a $\frac{1}{8}$-in. reamed seating, set to blow off at 30 lb. pressure. The boiler is fired by a spirit-lamp, consisting of a circular tank with three burners, as shown. It can be made from thin sheet iron or steel, and brazed, or from stout tin, and soldered; fit a push-in filler with a vent in the middle, also a "saucepan handle," for handling when hot.

The triangular winch frame-plates are cut out together from $\frac{1}{16}$-in. steel, just like locomotive frames; drill the stay holes with No. 34 drill, and the bush holes $\frac{1}{4}$ in. A $\frac{3}{8}$-in. hole is needed for the reversing-plate, and four holes for the screws securing the distribution or port block. The bottom edges are bent over for attachment to the baseboard, as shown. The bushes are turned from bronze or gunmetal rod, and squeezed in, the flanges being on the inside. The stay rods are made from 5/32-in. steel rod, the ends being turned down for about $\frac{3}{16}$ in. length, to 7/64 in. diameter, and screwed 6-B.A. They are fixed with ordinary commercial nuts. The winch drum can be turned from a casting, or built up from $\frac{1}{2}$-in. tube, with discs cut from 3/32-in. plate, silver-soldered on at each end. Even a cotton-reel would serve, if the hole in the middle is plugged, and a $\frac{3}{16}$-in. steel spindle put through it. Drill a hole through the barrel, and counterbore it as shown by dotted lines, to take the end of the hoisting rope. The large gear wheel can be pinned or setscrewed to the drum spindle.

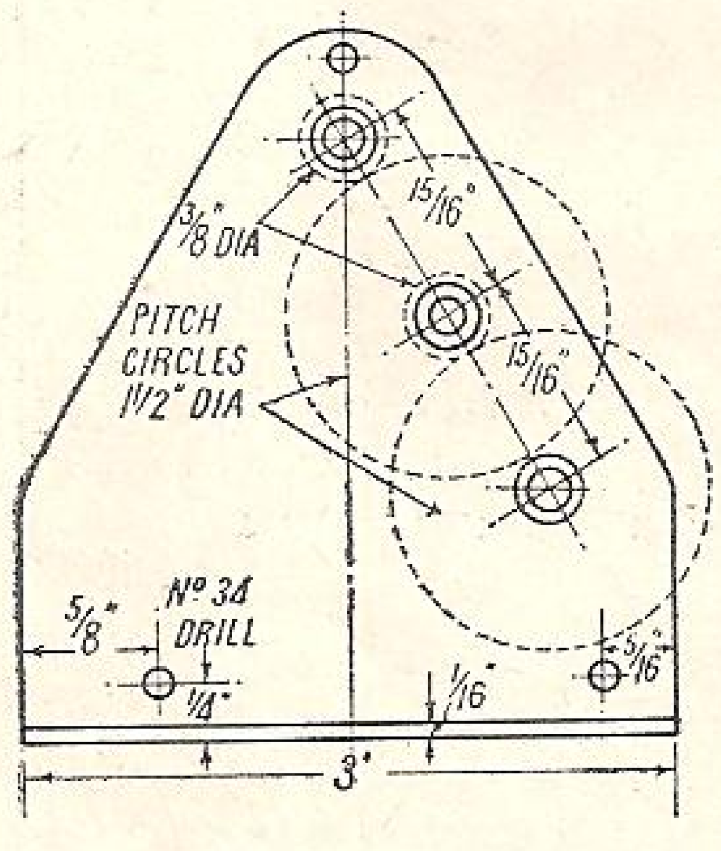
The intermediate shaft is 5/32 in. diameter, and carries a $\frac{3}{8}$-in. pinion, for meshing with the gear wheel on the drum spindle. Alongside it, is fixed another big wheel for taking the drive from the pinion on the crankshaft. A collar will be needed at the other end, to prevent the shaft from side-slipping. The crankshaft is $\frac{3}{16}$ in. diameter and $4\frac{1}{4}$ in. long, with a 1-in. disc crank at one end, and a pinion and flywheel at the other. The flywheel is needed, owing to the crane only having one cylinder. As mentioned above, any gear wheels can be used, within reason, if the shaft centres are arranged to suit.

Engine

The double-action oscillating cylinder is $\frac{7}{16}$ in. bore and $\frac{5}{8}$ in. stroke. It is bored and and faced, the port-



Inside of L.H. winch frame



Outside of R.H. winch frame

face machined, and the covers turned, in exactly the same way as described for locomotive cylinders. The gland is made from $\frac{5}{16}$-in. hexagon rod. The piston is turned from drawn bronze or gunmetal rod, and the piston-rod is $\frac{1}{8}$-in. rustless steel or bronze. The big-end is a plain block, drilled for the crank-pin, and screwed on to the end of the piston-rod. The trunnion-pin is $\frac{1}{8}$-in. round steel; take good care to have this dead square with the rubbing faces.

The distribution block, or port block, is a piece of bronze or gunmetal rod 1 in., long, $\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. thick. Face off both sides, and drill a No. 30 hole through the middle. Be mighty careful about marking out and drilling the ports and passages correctly. Drill the two longitudinal holes first, at 3/32 in. from one face, and 5/32 in. each side of centre. Next, drill the four ports so that they break into them. At the side, as shown, 3/32 in. from the edge, and 5/32 in. each side of centre, drill 3/32-in. holes $\frac{1}{4}$ in. deep, open with No. 30 drill to $\frac{1}{8}$ in. depth, and tap 5/32 in. × 40, as shown by the dotted lines. Now turn the piece over, and drill the four holes shown in a circle. The two at the sides, are drilled through into the longitudinal holes connecting the ports; the top and bottom ones break into the holes just previously drilled. True up both faces of the block, on a piece of fine emery-cloth, laid on the lathe bed, or some other surface equally true.

The reversing-valve is a $\frac{3}{16}$-in. slice parted off a piece of $\frac{1}{2}$-in. round rod. Drill a No. 30 hole through the middle, and countersink it. Make four deep countersinks, corresponding to the four ports in the back of the block, on one side of the valve, and run them into two sausage-shaped grooves, by aid of a small chisel. On the back, drill and tap a 9-B.A. hole for the screw for connecting to the rod from the reversing lever. This should come in the thick part between the grooves. Face the grooved side truly, as above.

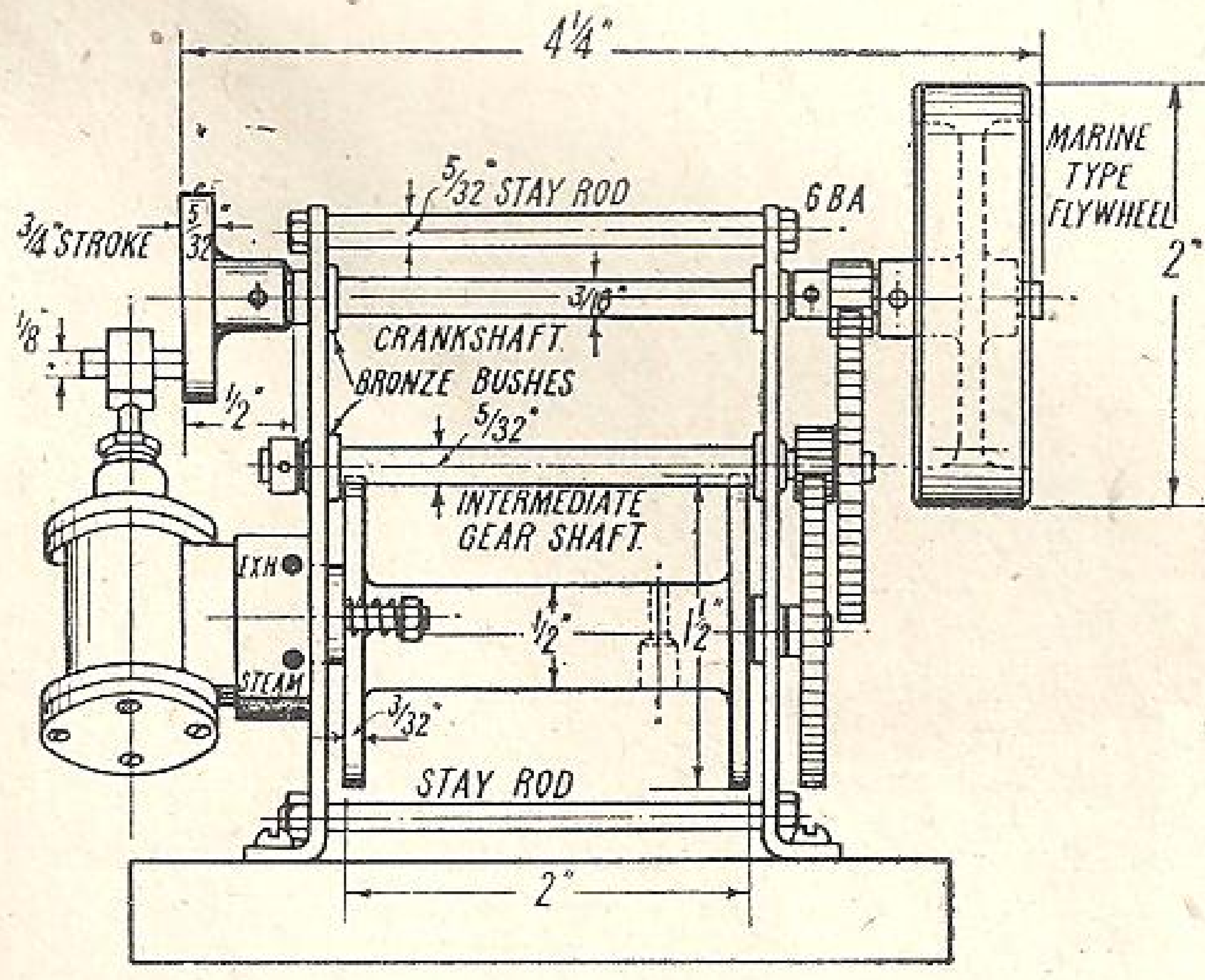
Temporarily clamp the port block to the outside of the l.h. winch frame, in the position shown by the dotted lines in the illustration; run the 41 drill through the holes in the frame, making countersinks on the port block. Remove block, drill the countersinks with No. 48 drill for $\frac{3}{16}$ in. depth, tap 3/32 in. or 7-B.A., and attach the block to the frame by cheese or roundhead screws. Warning: the screws must not pierce the passages, so watch your step when drilling and tapping.

The cylinder can then be erected, with the trunnion-pin going through the hole in the block. Put on the reversing-valve, and secure with a 19-gauge steel spring and nut. Make a lever, in the same way as described for locomotive reverse levers, and pivot it on a small shouldered screw in the left-hand winch frame, as shown; connect the lever to the screw in the back of the reversing-valve, by a link made from $\frac{1}{16}$-in. × $\frac{3}{16}$-in. steel strip. The stop pins, which are made from $\frac{1}{16}$-in. wire screwed into the winch frame, are set so that when the lever is in the upper position, one of the curved grooves in the reversing-valve bridges the steam port (bottom) and one of the side ports, whilst the other groove bridges the exhaust port (top) and the other side port. Shifting the lever to the lower position, should move the reversing-valve a quarter-turn, the grooves then bridging the opposite ports, and reversing the engine. The completed winch is attached to the baseboard by woodscrews, as shown.

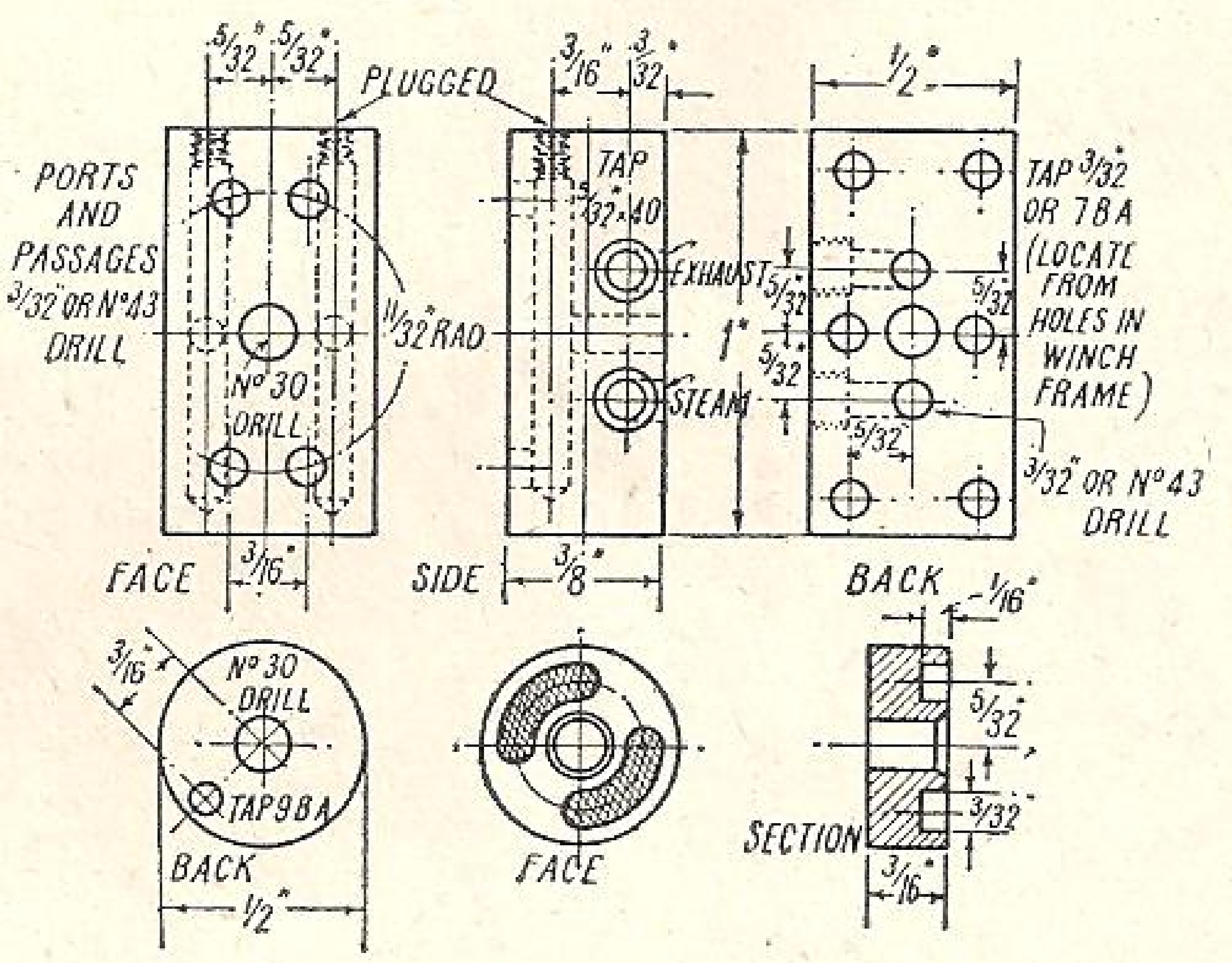
Throttle and Lubricator

Steam is controlled by a simple screw-down valve, the handle of which is far enough away from it, to avoid burning tender fingers, and big enough to allow of easy operation. The valve is very similar to the type described in a recent lobby-chat, having a separate section to carry the valve-pin. The body is a $\frac{7}{8}$-in. length of $\frac{5}{16}$-in. round or hexagon rod; chuck in three-jaw, face the end, centre, drill down for $\frac{13}{16}$ in. depth with 3/32-in. or No. 41 drill, open out and bottom to $\frac{7}{16}$ in. depth with 7/32-in. drill and D-bit, tap the end $\frac{1}{4}$ in. × 40 and make a gland fitting to suit, as shown. Tap this for a 5/32-in. × 32 pin. At $\frac{5}{16}$ in. from the tapped end, drill a 5/32-in. hole right across; and at $\frac{1}{4}$ in. from the blank end, drill another at right-angles. This one should break into the small hole. Fit $\frac{1}{4}$-in. × 40 union nipples into two of them, as shown; the lubricator goes into the third.

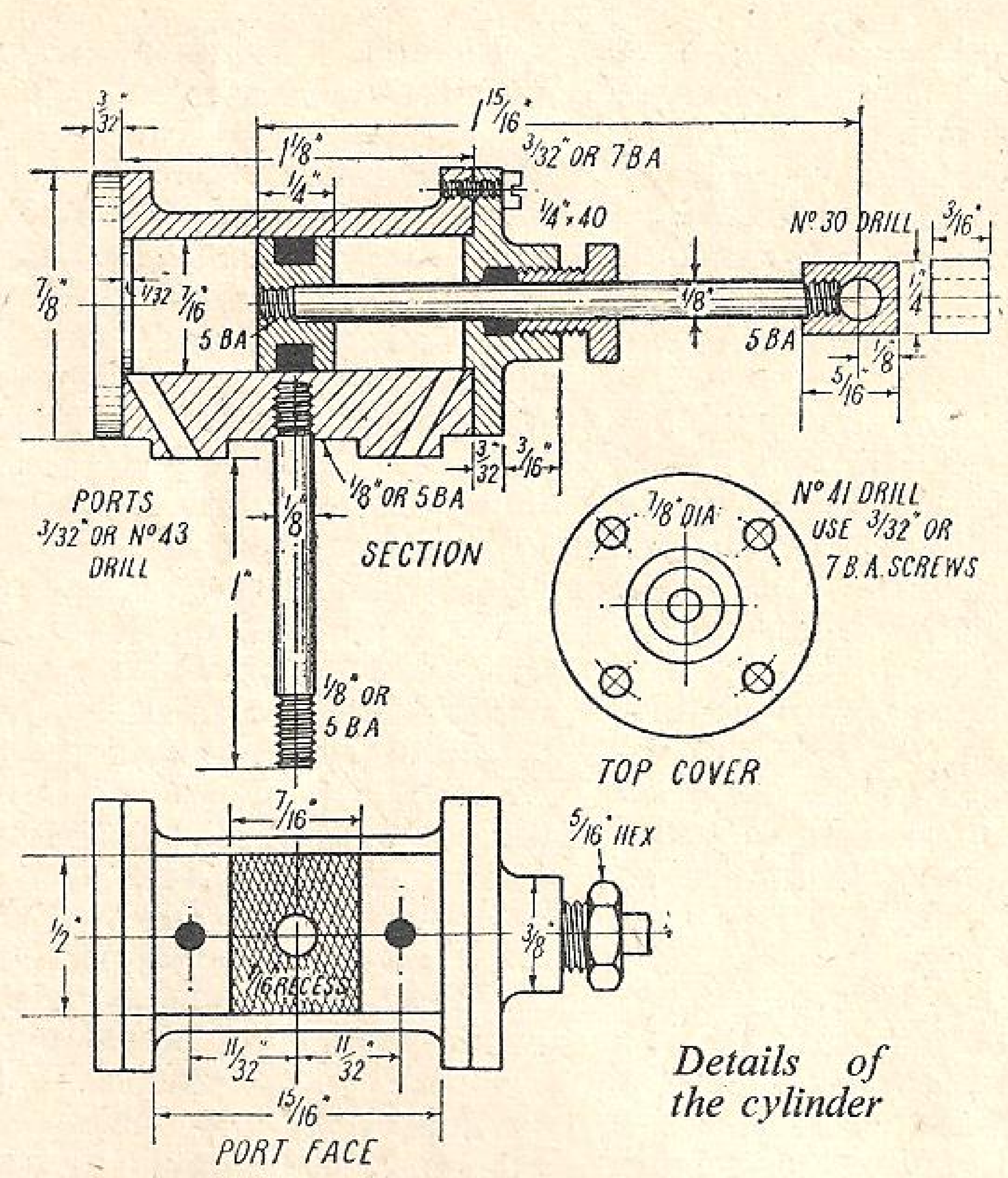
The lubricator is just a plain oil cup, made from $\frac{3}{8}$-in. round rod, turned to the shape and dimensions shown, and fitted with a screwed cap. The stem is turned a tight fit for the hole in the valve body, and is drilled No. 70. The two union nipples, and the lubricator, are silver-soldered in at one heat. The valve pin can be made to any length that the builder fancies. On the end of it, fit a 7/32-in. boss, carrying a cross handle, made like a tender brake-handle; this is much better than a wheel, for operation by a kiddy. It gives more leverage, and doesn't slip when operated by small oily fingers. Kids don't reckon they are really on the job, unless their hands are dirty and oily!



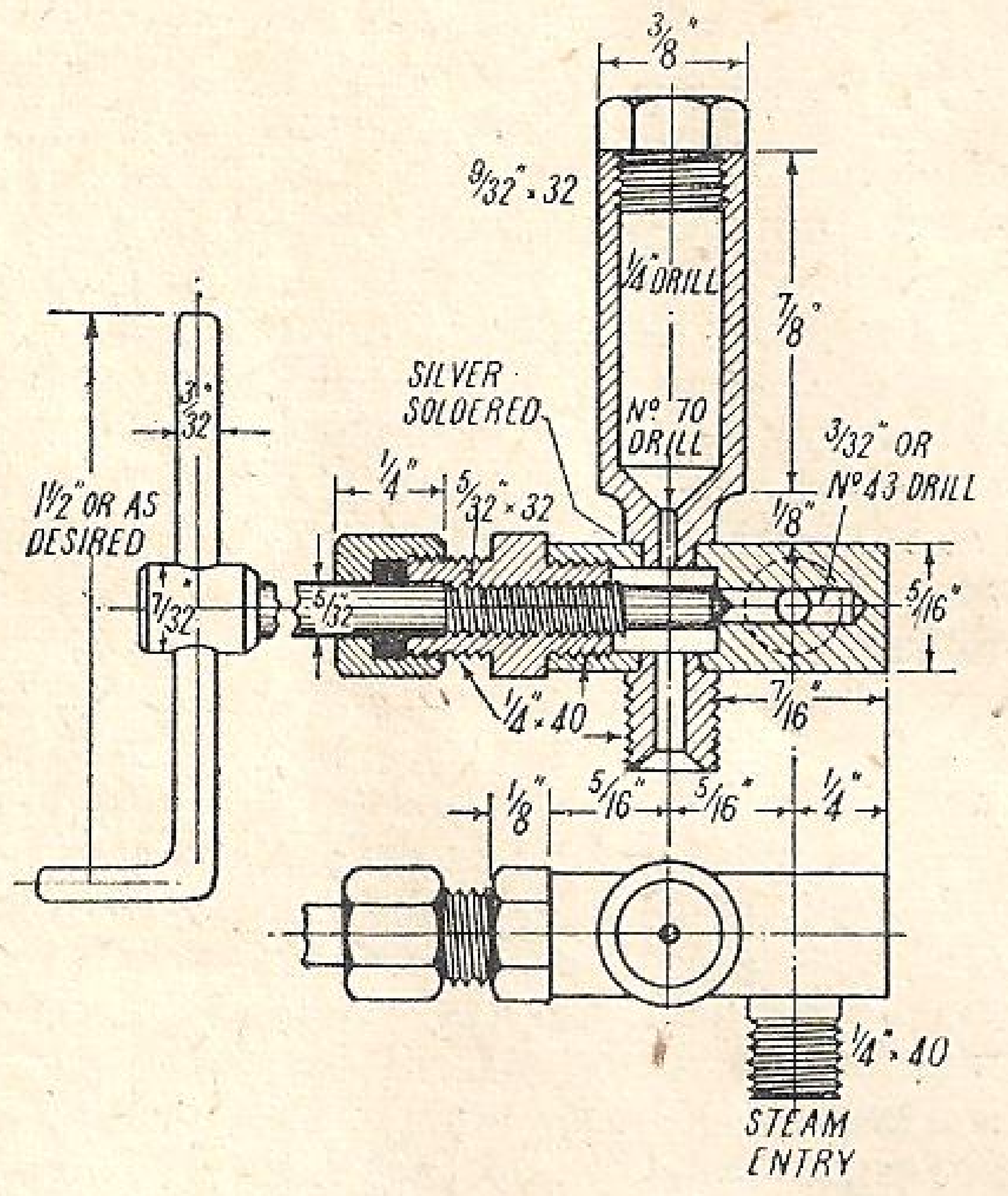
Back view of winch



Port block and reversing plate



Details of the cylinder



Combined throttle and lubricator

The union nut and cone on the superheater, are connected to the union nipple at the blank end of the throttle-valve. A short bit of 5/32-in. pipe with a union nut and cone, is screwed into the lower hole in the port block, and connected to the union nipple directly under the lubricator. The two pipes should hold the valve in place, without any other support being needed.

The exhaust pipe is 5/32 in. diameter, and arranged as shown in the side view of the crane. The pipe should be softened, and the upper end hammered into a cone; run a 3/32-in. drill into the end, in case it has been closed up too much. Bend the pipe as shown, and push the upper end into a 5/32-in. hole drilled at the bottom of the chimney. The lower end is connected, either by a union or a running-nut, to a short bit of pipe screwed into the upper hole in the port block.

Jib

The jib is a piece of H or channel-section brass or steel, about 12 in. long; for sake of appearance, it could be filed taper. It is held at the bottom by two pieces of angle, bent up from 16-gauge steel, as shown in the illustration; these are screwed to the baseboard, and a $\frac{3}{16}$-in. pin or bolt put through the lot. The upper end carries a round-grooved pulley, $\frac{1}{2}$ in. diameter, on a $\frac{1}{8}$-in. spindle. Leave the spindle projecting at each side, and attach either pieces of flexible wire, as used for picture-hanging, or small chains, to the projections. Anchor the other ends of them to a couple of tags under the nuts at the ends of the top staybar on the winch frame. The jib can be sloped at any angle that the builder—or the kiddy — fancies. The wires or chains could be made adjustable, if needed.

How to Operate the Crane

Fill the boiler through the safety-valve bush, until water runs out of the test cock; then shut the cock, and replace the safety-valve. Fill the lamp about three-parts full of methylated spirit, using asbestos string or flock for wicks, and leaving them loose. While the kettle is boiling, oil all the bearings—don't forget the jib pulley—and fill the lubricator with cylinder oil, super-heater grade, the stuff that looks, but doesn't taste like molasses. For the hoisting rope, use about a couple of yards of stout fishing line; poke one end through the hole in the winch drum, tie a knot in it, and pull the knot back into the enlarged part of the hole, so that it is below the surface of the winch barrel, and won't interfere with the rope coiling up evenly.

When steam is up, put the reverse lever in the upper position, and open the throttle a little; if the crank stops on dead centre, give the flywheel a flick, to teach it good manners. Hold the rope in your fingers, letting it run over the jib pulley, whilst the engine winds the rope on to the drum. When it is all wound on, except a few inches below the pulley, shut off steam, and thread a lead or brass weight on the rope as shown, tying a wire hook just below it. The weight is to keep the rope taut, when lowering with nothing on the hook. The crane is then O.K. for service.

The lucky kiddy will be able to hoist quite a decent load off the floor, slew the crane around, and lower the load on to the table or window-sill. A load can be picked up from the garden, and decanted inside the room. Young Curly's home-made steam crane was a source of delight to my few small cronies; on one occasion, we nearly sent the poor old cat into hysterics, by dumping her quads into mother's shopping-basket, and hoisting the lot up to the first-floor window !

I hope that the little crane described above, will give the kiddies many hours of pleasure. All the maintenance it needs, is to keep the bearings oiled, the lubricator supplied, and a drop more water in the boiler whenever the lamp goes out. Extra blobs and gadgets may, of course, be fitted. A locomotive whistle would be useful for the driver to signal to his—or her—mate below, and a clackbox and pump could be fitted, to feed the boiler with water under steam. Other refinements could include a steam gauge, and a water-gauge. Anyway, there is the nucleus; do what you jolly well like with it, as long as it pleases the weans and makes them happy !

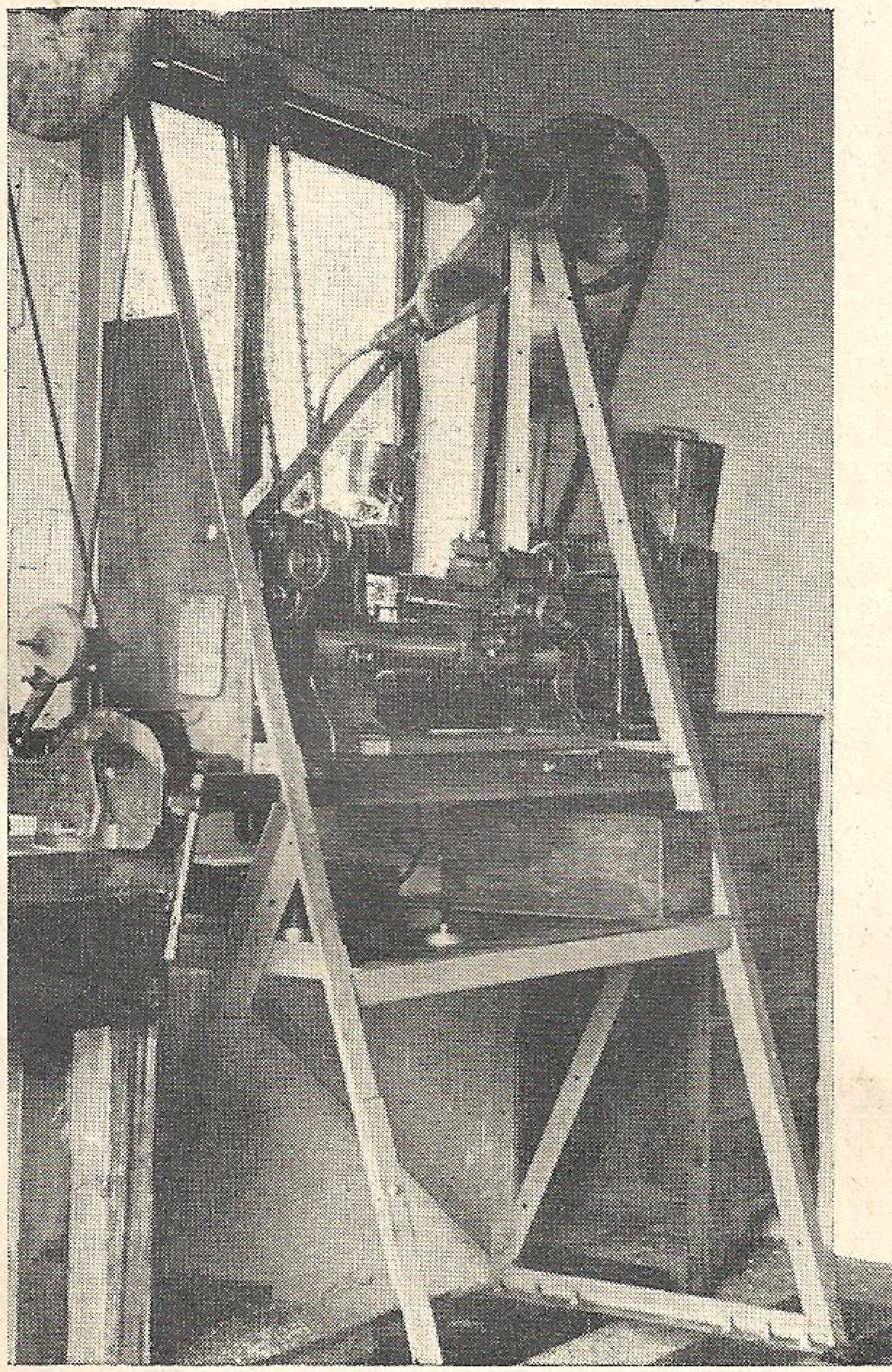
The story of a SEMI-PORTABLE WORKSHOP

By "Molmutius"

MY first lathe was built thirty years ago from the design in the late Henry Greenly's book *Model Engineering*. I was 13 then, and made the patterns during my school holidays under expert guidance. The small, but obliging firm who produced the castings allowed me to "machine" them in their shop. The "machine" was a drill and, I am afraid, the alignment of bed and mandrels was a little out. With the aid of hacksaw and file, however, I did produce a lathe. The stand was to my own design, and with civil engineering already dormant in my blood, was of two-inch square deal with tensile bracing of quarter-inch diameter mild-steel. The flywheel, of overlapping wooden segments screwed together and weighted with huge "cast in situ" lead slugs, is still commemorated in burnt floor boards in what is now the office of a nationalised industry.

For five years my turning was lubricated with mingled pride, self criticism and honest sweat. Then for about £13 or £14 (Oh happy days!) I bought a four-inch round-bed Drummond lathe and a $\frac{1}{4}$-h.p. motor. As a countershaft was necessary, a further 8s. produced two fine cast-iron hangers with split brasses. The scrap yard provided one-inch shafting and, miraculously, a matching cone pulley.

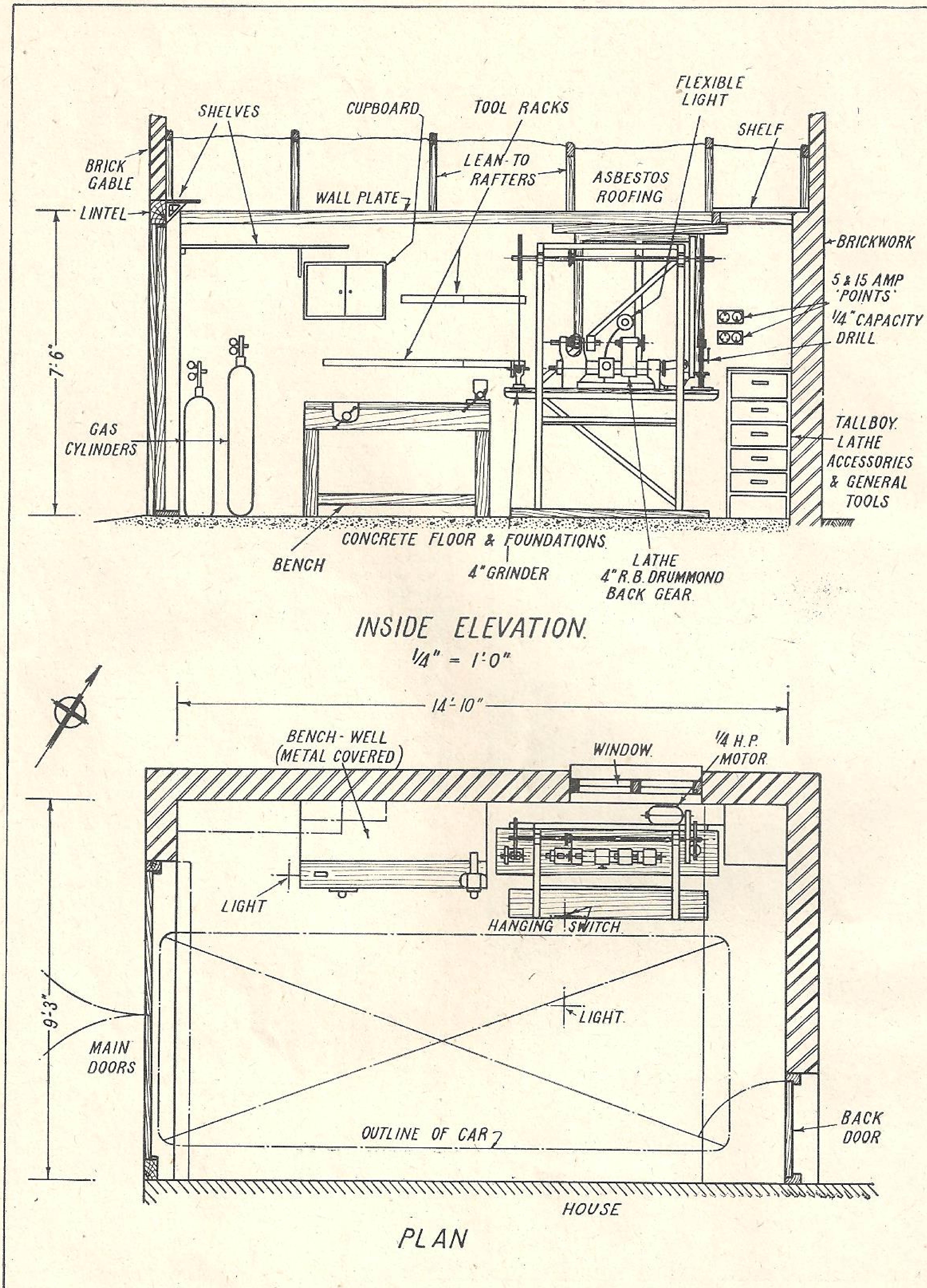
A large Rawlplug chisel soon put two sets of holes through the kitchen wall. Unfortunately it also put a brick through! The family, of course, were out, and my civil engineering studies, then commencing, led me rapidly to aluminous cement. Two orange-box ends shuttered and hid the ravages on the working face, and moving a bookcase about a couple of feet in the adjoining corridor hid the far side.



The machine-stand erected, ready for use

A civil engineer, bent upon, but never succeeding in making his fortune, is inclined to be peripatetic, and although the hangers were eventually sold—at a profit—and replaced by a heavy timber frame taken to pieces and reassembled for each new resting place, the set-up was unwieldy, and when space requirements forced my workshop upstairs, rather punishing to normal house construction. When, then, in 1946 I returned from the R.A.F. to find growing children requiring a garden swing, the heavy timbers were surrendered and a new design evolved. I had, for some time, been aware of the merits of bedstead angle-iron, having used it extensively for cleats. It is of very varied texture, from soft as butter, to next-door to impossible to hacksaw or drill, but it is cheap, very cheap, and it is readily available and light. The drawing shows the design; the longer members of the frame are spliced, bedsteads being of limited length. All joints are made with two $\frac{5}{16}$ in. round-head Whit. screws and nuts, so that the whole comes to pieces easily and quickly. I am toying with the idea of welding each side frame into an integral unit, without any screws, but as the shelf underneath was an afterthought, easily added with the present type of construction, I am holding off until I am sure that the design is perfect. Does a model engineer ever reach that most unsatisfactory state of mind? Bedstead angles, by the way, vary quite a bit in cross-section. I am not sure if there is a British Standard! The heavier sections were, therefore, selected for the main frame and horizontal members, and the lighter ones were used for the side frame and cross bracing. The countershaft bearings which followed the split brasses were a pair of abandoned car ball-races, bushed to one inch diameter and mounted in beech blocks, split on the centre-line and housed to take them. A tinplate cover kept dust out. These have now been most satisfactorily replaced by a pair of cheap and neat modern die castings with impregnated bushes.

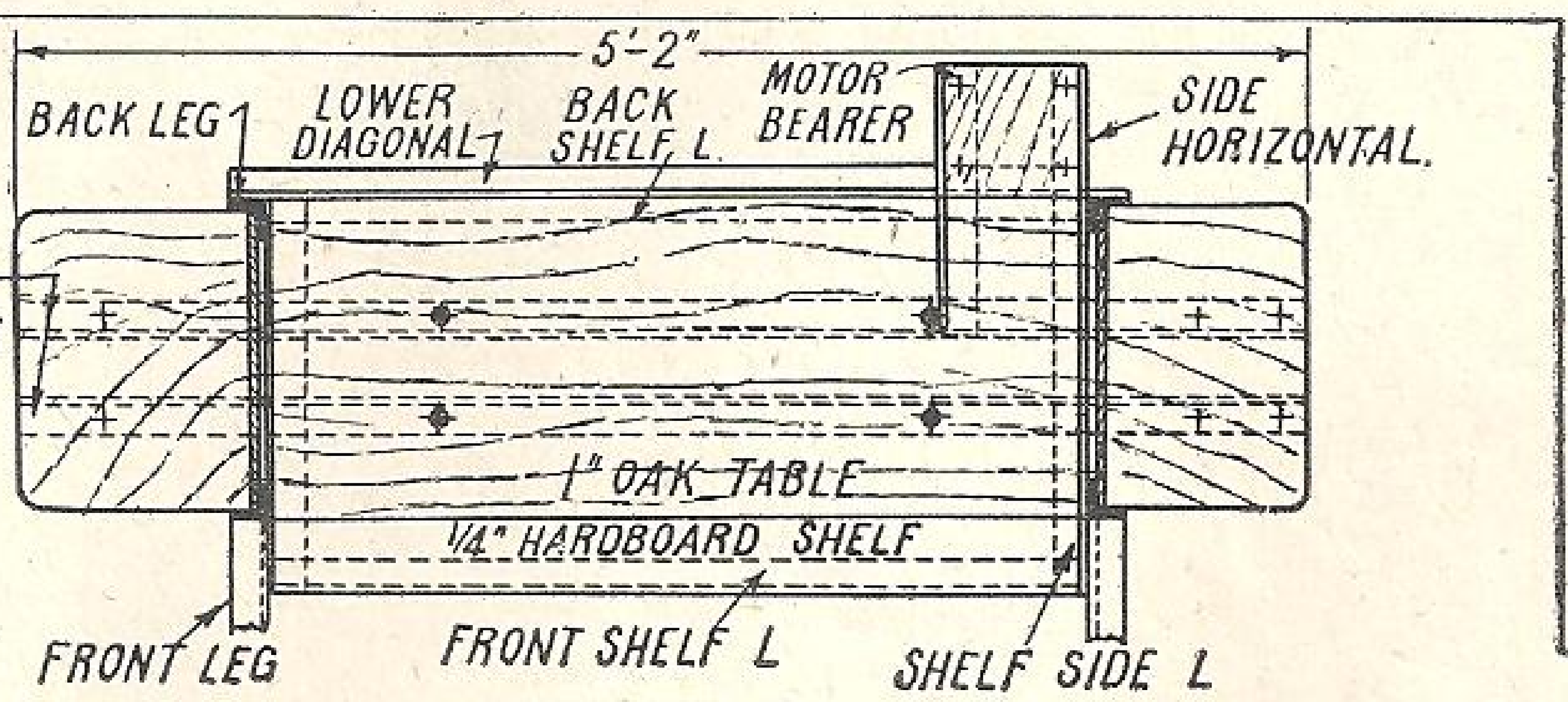
There is a modern tendency to hinge the table on which motors are mounted, but although this was tried as an experiment, I have not found my motor heavy enough to ensure a positive drive against heavy cuts, and as the rigid attachment shown works excellently, the complication has been avoided. A high-speed drill for small sizes is almost essential on model work and so is some method of tool sharpening. Electric motors are ex-


SHELVES
CUPBOARD
TOOL RACKS
FLEXIBLE LIGHT
SHELF
BRICK GABLE
LINTEL
LEAN-TO RAFTERS
WALL PLATE
ASBESTOS ROOFING
BRICKWORK
5 & 15 AMP 'POINTS'
1/4" CAPACITY DRILL
7'6"
GAS CYLINDERS
TALLBOY LATHE ACCESSORIES & GENERAL TOOLS
CONCRETE FLOOR & FOUNDATIONS
BENCH
4" GRINDER
LATHE 4" R.B. DRUMMOND BACK GEAR
INSIDE ELEVATION
1/4" = 1'0"
14'-10"
BENCH-WELL (METAL COVERED)
WINDOW
1/4 H.P. MOTOR
LIGHT
HANGING SWITCH
9'3"
LIGHT
MAIN DOORS
OUTLINE OF CAR
BACK DOOR
HOUSE
PLAN

pensive, and a Scottish education leads me naturally to economies. The result is that the two horizontal angles forming the support for the lathe bed have been extended through the side frames to carry, on plywood tables, a $\frac{1}{4}$-in. Champion drill and grinding head, at opposite ends of the extended countershaft. These two items are brought into use by slipping the round belts on to the respective pulleys at will. One of these pulleys is another die casting, but the other is still a home-made affair of three plywood discs, a 1-in. collar, a large washer, and three $\frac{1}{8}$-in. setscrews. The side frame alongside the grinder has been blanked off with another sheet of plywood, to prevent emery dust reaching the mandrel, but to allow of using the hollow mandrel, the wood is holed and fitted with a "keyhole" type cover. The inside of the plywood carries screws upon which hang spanners, driving dogs, etc. A little war-time "loot" in the form of a flexible-stem lamp fits behind the lathe, and is absolutely invaluable. It is long enough to reach the drill if required. Along the back of the frame is a timber, holed on the top to carry centres, chuck arbors, etc. The whole set-up is mounted on two 8-in. by 2-in. timbers, which although hardly necessary on the concrete floor of the present home-built garage, prove their worth when used to distribute load and vibration through the floor joists of a bedroom.

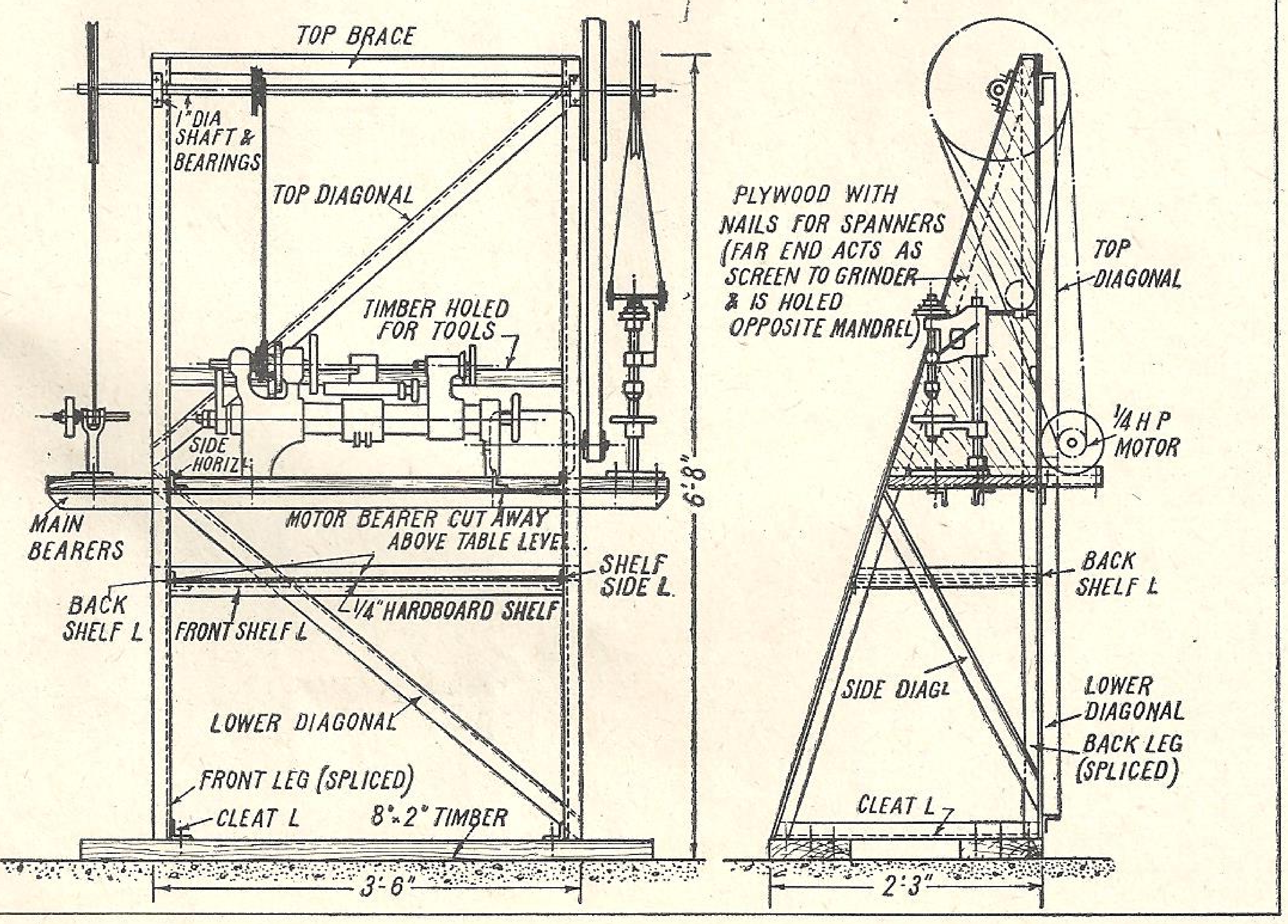
I sometimes read the advertisements for Boxford, M.L.7, and similar lathes, a little wistfully, but having fitted my old Drummond with a most fascinating compact backgear, I doubt now if I shall ever part with it, no matter how my fortunes may increase! The change has necessitated an alteration in drive from a 1-in. flat leather belt to a patent continuously-jointed vee-type, but this has given no trouble at all, and although it takes a minute or two to break, when this is necessary, it is absolutely silent. A pair of home-made lubricators have been fitted, with good results to the headstock bearings, and all other oil holes have been covered with cycle type oil cups to keep out dust and swarf. In order to preserve the cutting oil which drips from a tap soldered into a cocoa tin mounted on a sort of retort stand screwed to the cross-slide, the bench carries a large tray arranged with a fall to one corner. Here the lid of a Virol jar has been soldered to the underside and a hole cut through both tray and lid. The Virol bottle itself screws up through a hole in the timber to catch the precious oil. A circle of fine copper gauze acts as a filter, and a gallon of Houghtolard has lasted me for years.

Round-bed Drummonds are still to be had in good condition at reasonable prices. Small drilling machines and grinding heads can be home-made. The rest is easy. Why be without a workshop?



Left: *Plan of table and shelf (machines removed)*

Below: *Elevations of machine stand*



IN THE WORKSHOP

BY DUPLEX

A JIG-SAW MACHINE

NOW that the driving mechanism has been completed, the next step is to make and fit the saw table and the frame supporting the upper end of the saw blade.

The Table Bedplate—Qa

Mild-steel plate, $\frac{1}{2}$ in. in thickness, is used for making this part, which at its forward end is secured to the motion plate by two $\frac{1}{4}$ in. diameter Allen cap-head screws. When the motion plate is mounted in position and this bedplate secured to it, the bedplate should lie evenly on the boss at the forward end of the motion plate bracket casting and also, at its rear end, on the 5/32 in. distance collar resting on the flat machined on the other lug of the same casting.

With the parts secured in this position, the bracket casting is detached and turned upside-down. This will enable the casting to serve as a guide for drilling and reaming a $\frac{1}{2}$ in. diameter hole through the bedplate to take the frame column.

The Table Supports—Qb

These are made from mild-steel to the dimensions given in the drawing, and each is then secured to the table bedplate with a single, $\frac{1}{4}$ in. diameter Allen cap-screw, inserted from below.

The Saw Table—Qc

Mild-steel plate, $\frac{3}{16}$ in. in thickness, is amply rigid for making the saw table. After the material has been finished smooth and flat on its upper surface, it is secured to the table supports by means of four long bolts with recessed heads. It is important that all four sides and edges of the table should be made true and square, and also that the table itself should be mounted square with the motion plate, for these edges serve as datum surfaces both when sawing and when setting the work fences.

The saw frame, having a throat depth of $4\frac{3}{8}$ in., is admittedly shallower than is usual in commercial machines, but this capacity will be found sufficient for most work and helps to maintain the rigidity and compactness of the machine.

However, the throat depth was, in part, dependent on the size of the materials and castings available at the time; but, if a greater work capacity is required, this could be met by using a deeper frame in the form of a properly proportioned casting in iron or aluminium alloy, and at the same time fitting a slightly smaller crankshaft pulley.

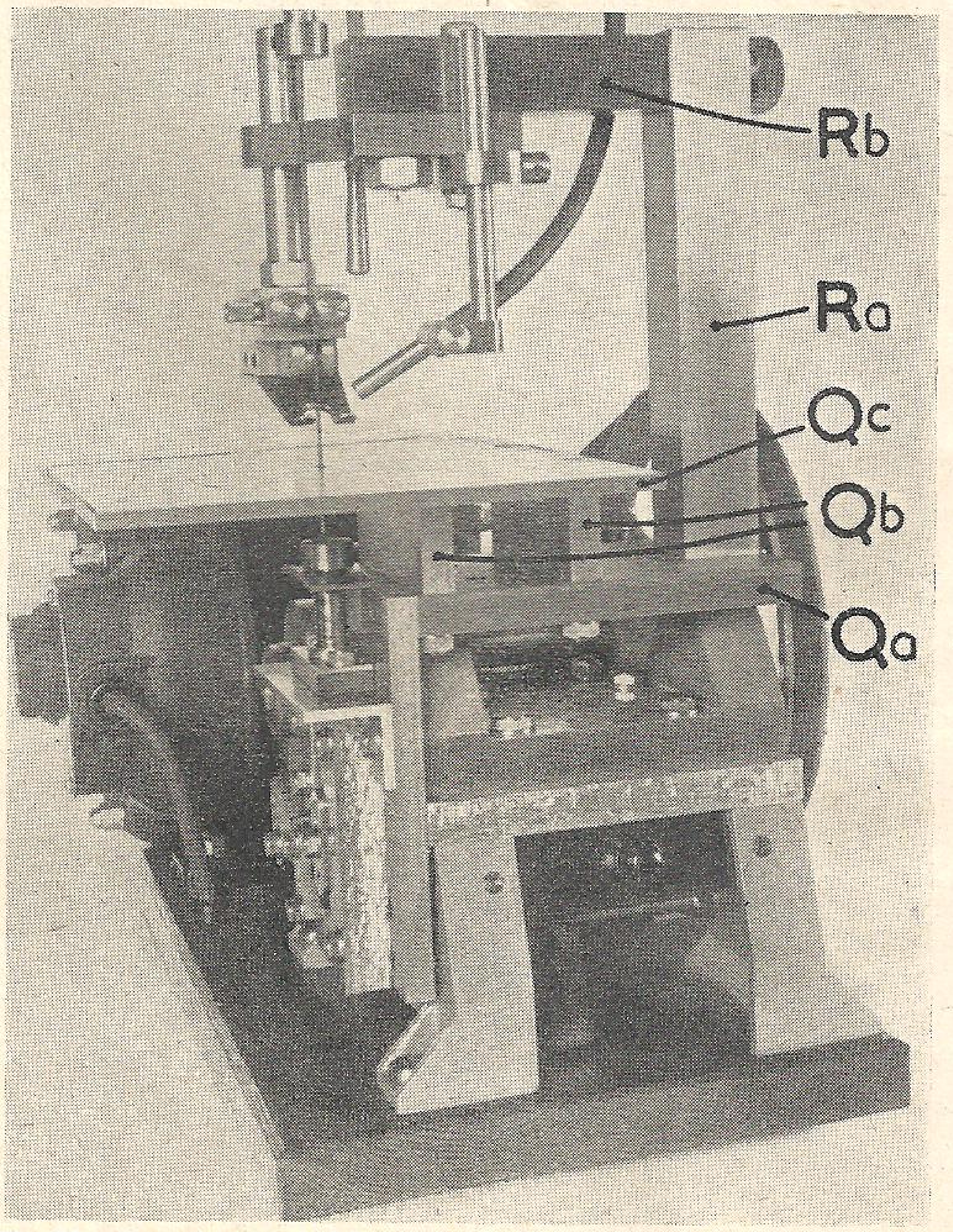


Fig. 23. Qa—the table bedplate ; Qb—table supports ; Qc—the saw table ; Ra—the saw frame column; Rb—the frame arm

Continued from page 398, October 1, 1953.

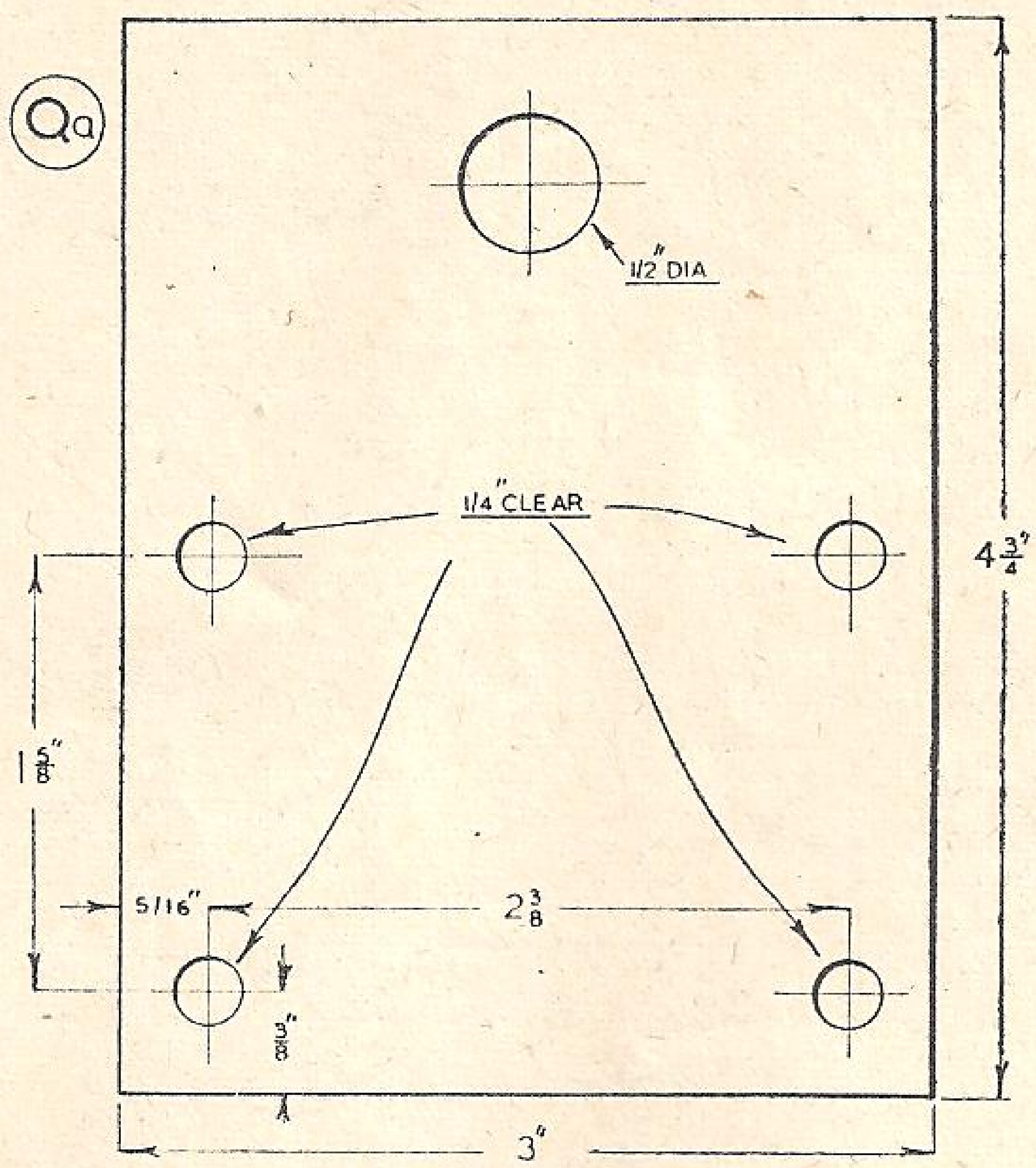


Fig. 24. The saw table bedplate

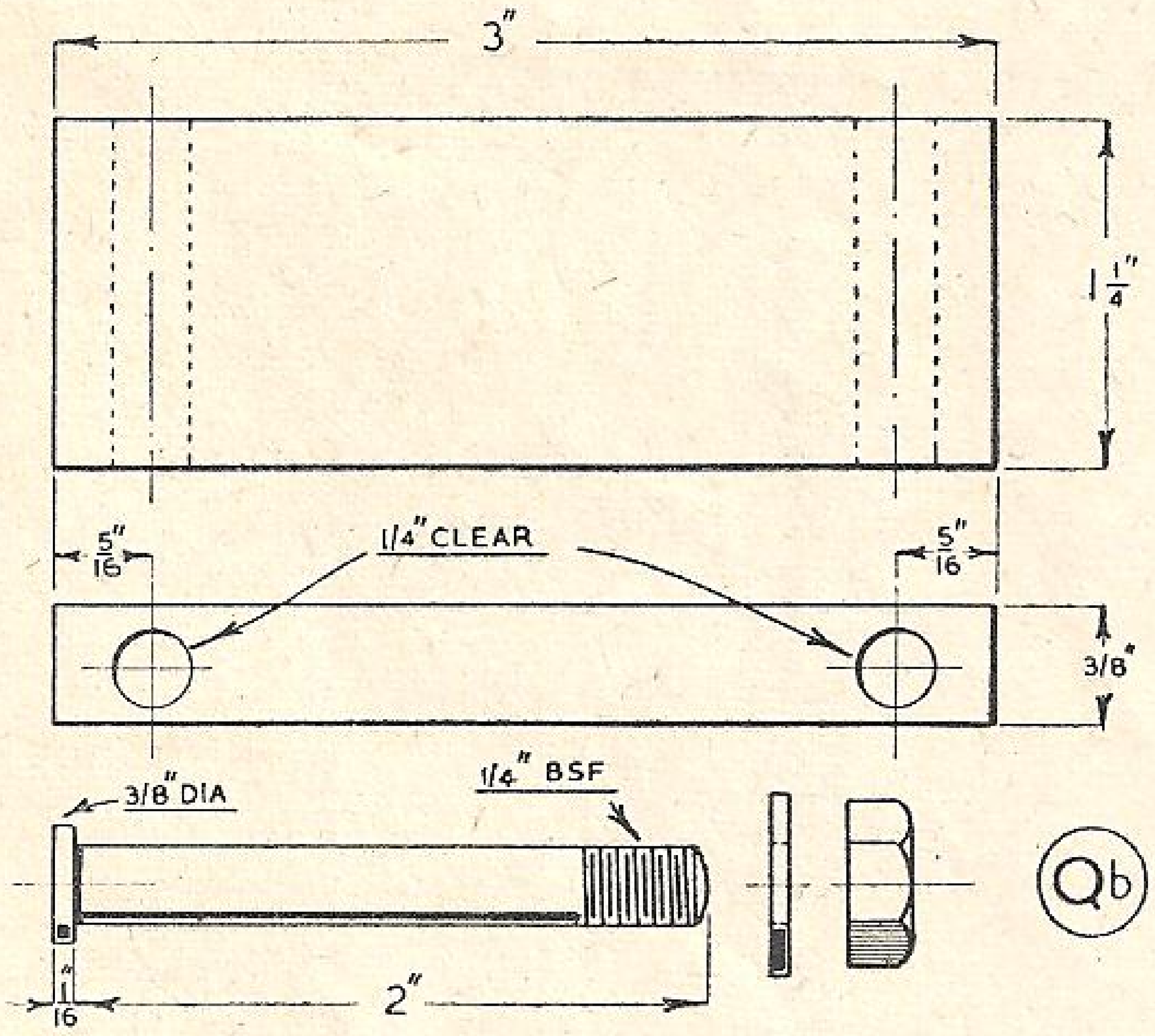


Fig. 25. The table supports and fixing-bolts

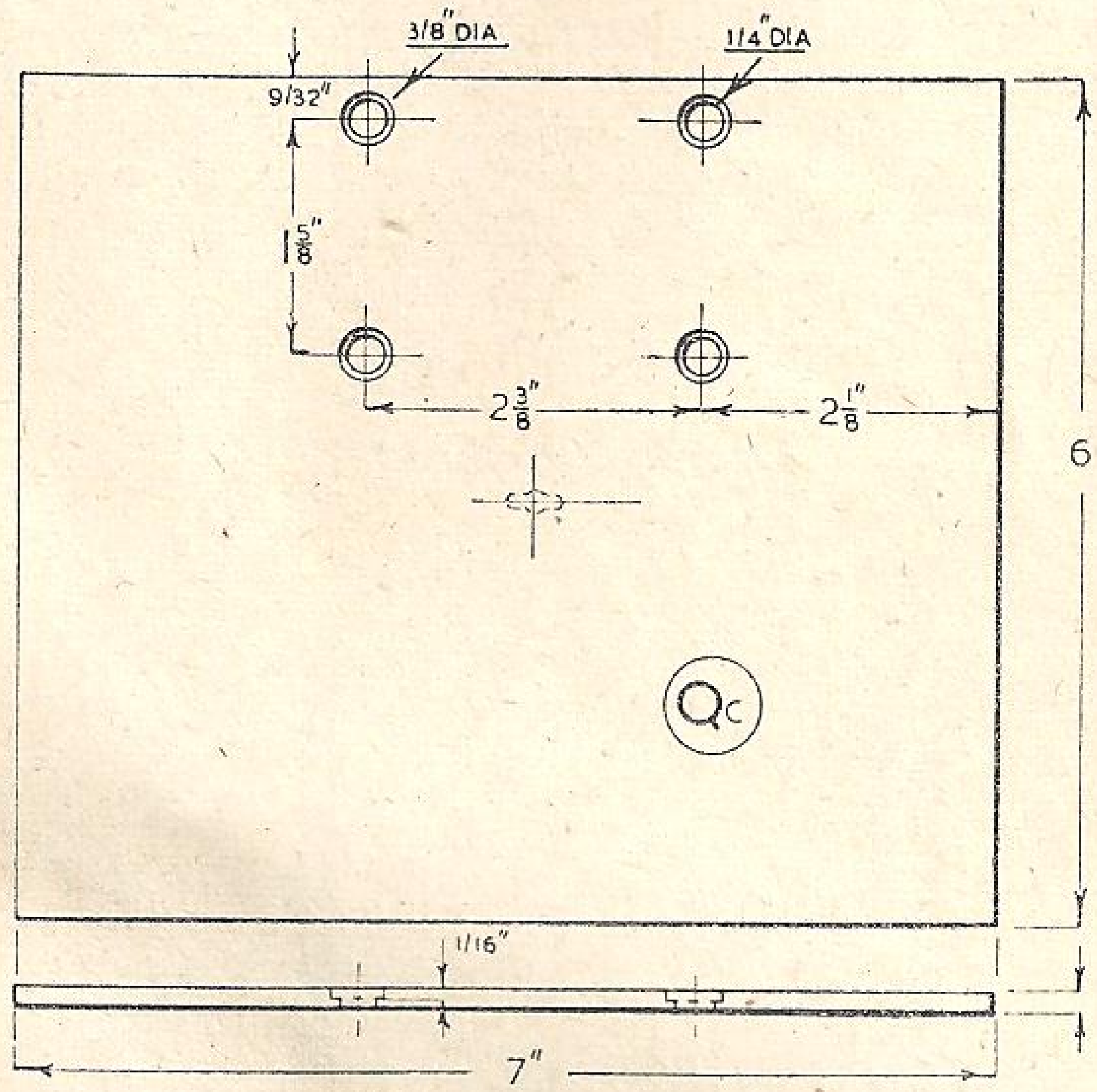


Fig. 26. The saw table

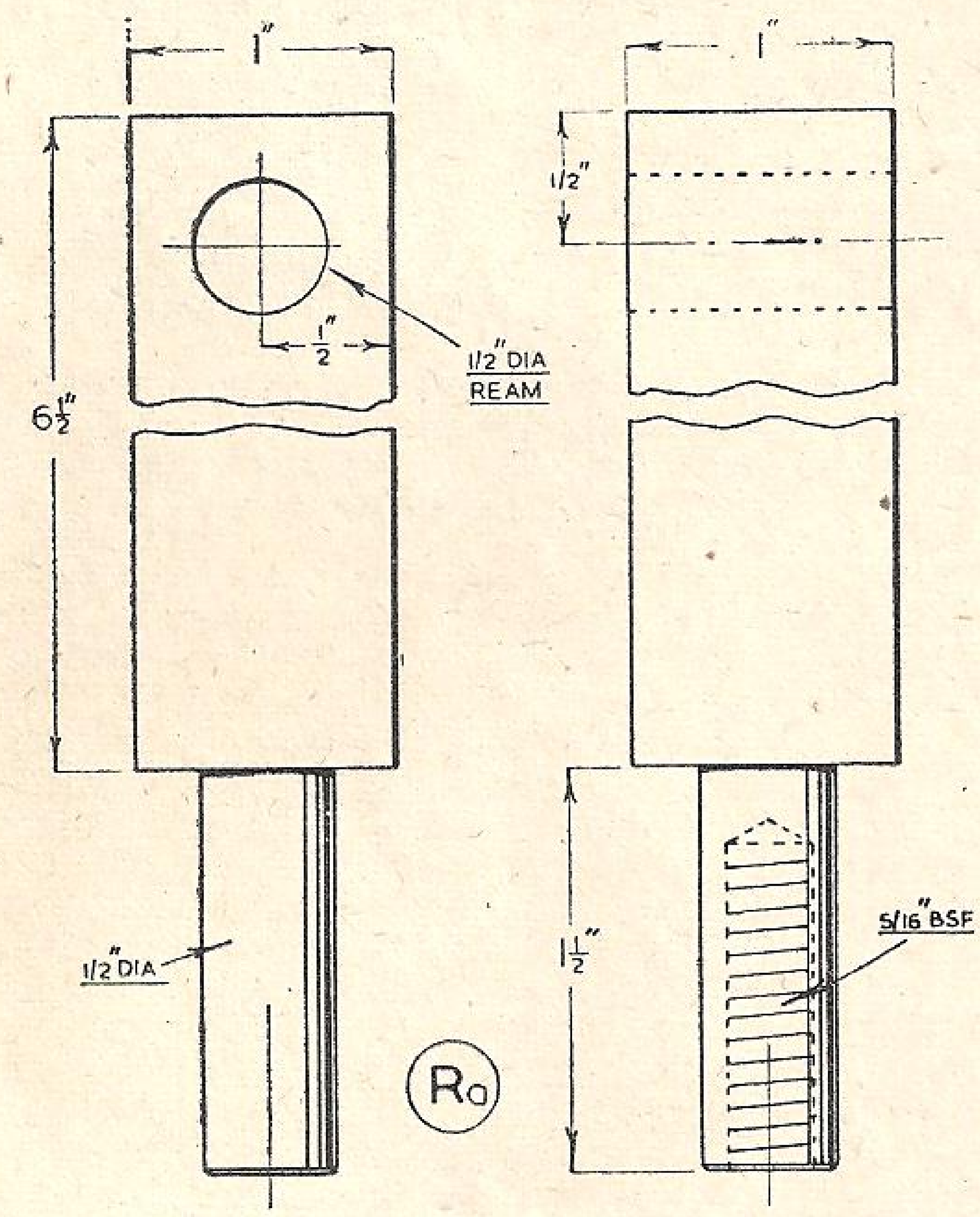


Fig. 28. The saw frame column

The Saw Frame Column—Ra

A length of 1 in. square mild-steel is carefully marked-out and centre-drilled at either end for machining between centres in the lathe. The lower end is shouldered down to give a wringing fit in both the table bedplate and the motion plate bracket casting. To drill and tap the lower end of the column for the $\frac{5}{16}$ in. diameter Allen fixing screw, the upper end is centred in the four-jaw chuck with the lower end supported by the tailstock centre. The fixed steady can now be used to support the work instead of the tailstock, and the axial hole is then drilled and tapped. Finally, the upper end of the column is cross-drilled and reamed for mounting the next part of the frame.

The Frame Arm—Rb

This horizontal member of the saw frame is made from $\frac{7}{8}$ in. square mild-steel. Again, the work is centred at either end, and one end is shouldered down to form a wringing fit in the frame column, where it is secured in place with a nut and washer. As shown in the drawing, this part is cross-drilled at two points to carry additional fittings.

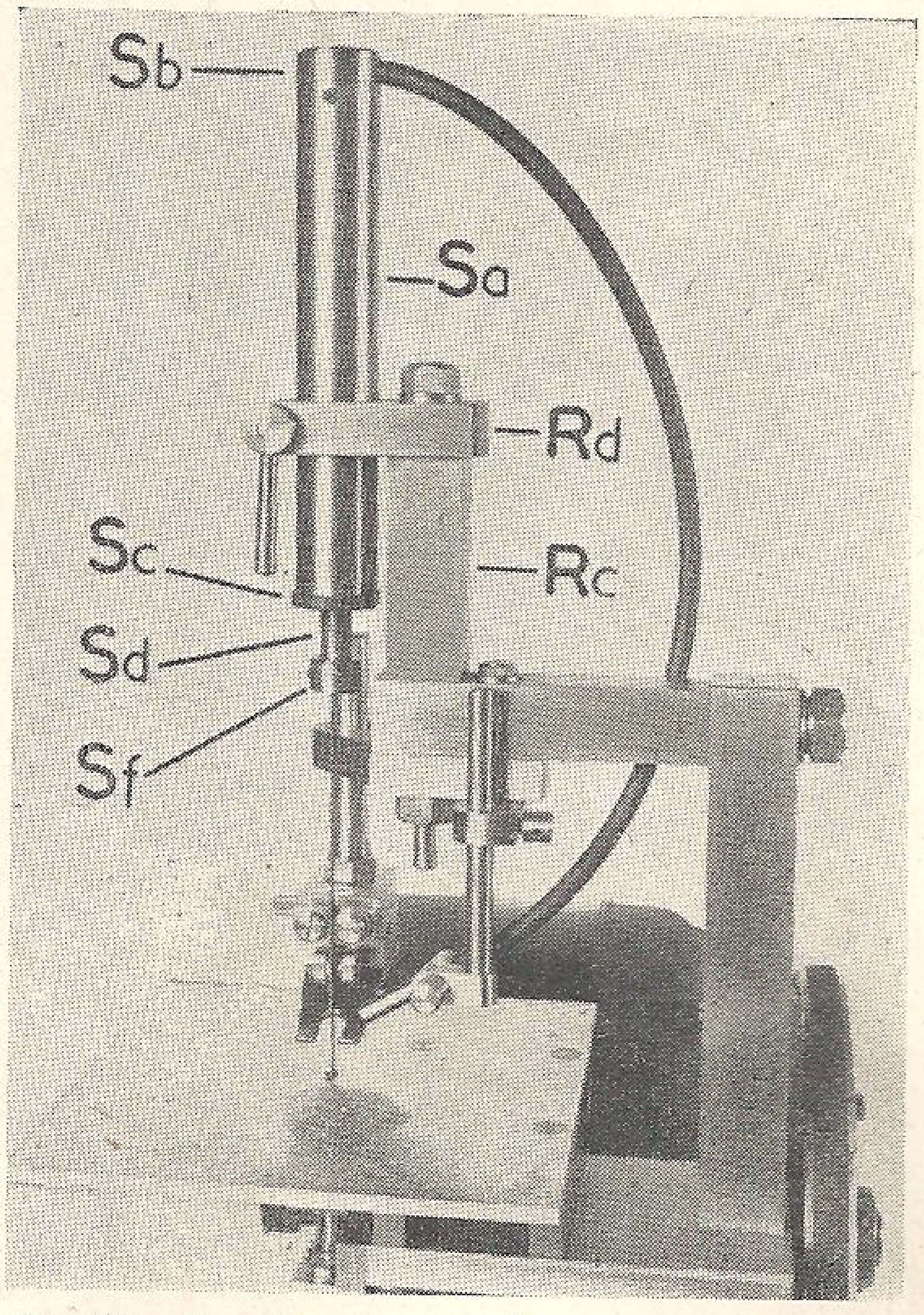


Fig. 27. Rc—the frame pillar; Rd—the cylinder bracket; Sa—the cylinder; Sb—the cylinder cap; Sc—the piston-rod guide bush; Sd—the piston-rod; Sf—the saw blade clamp collar

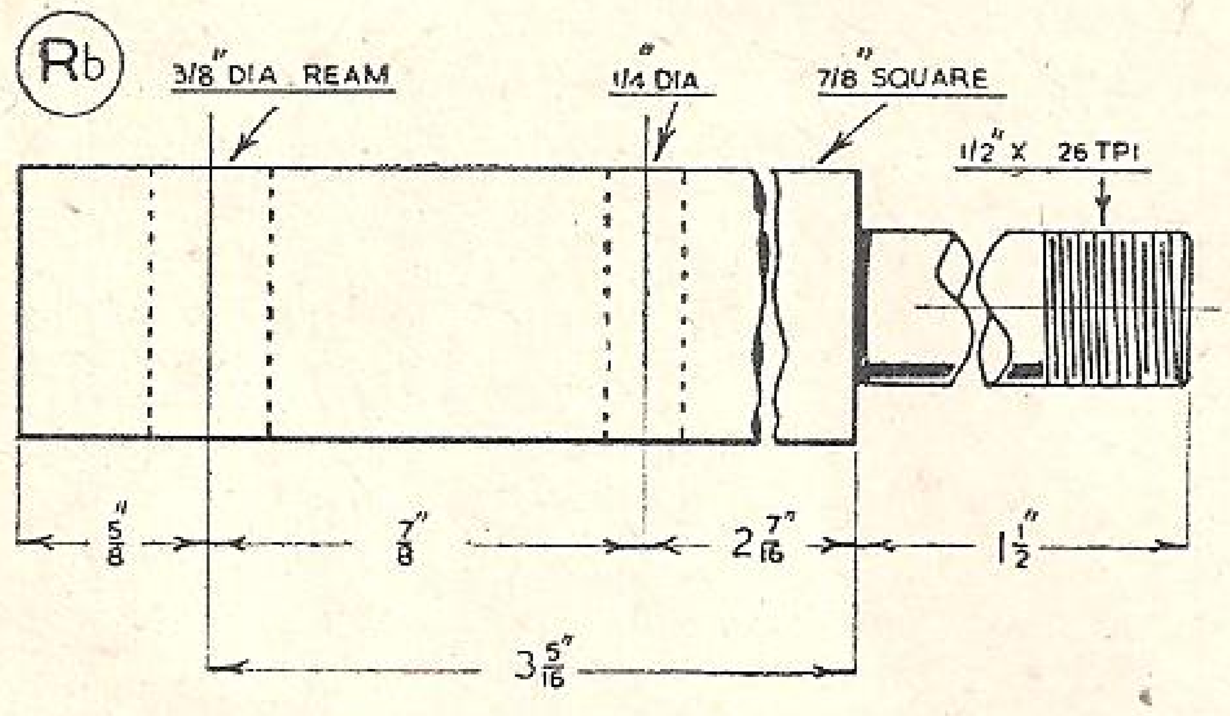


Fig. 29. The frame arm

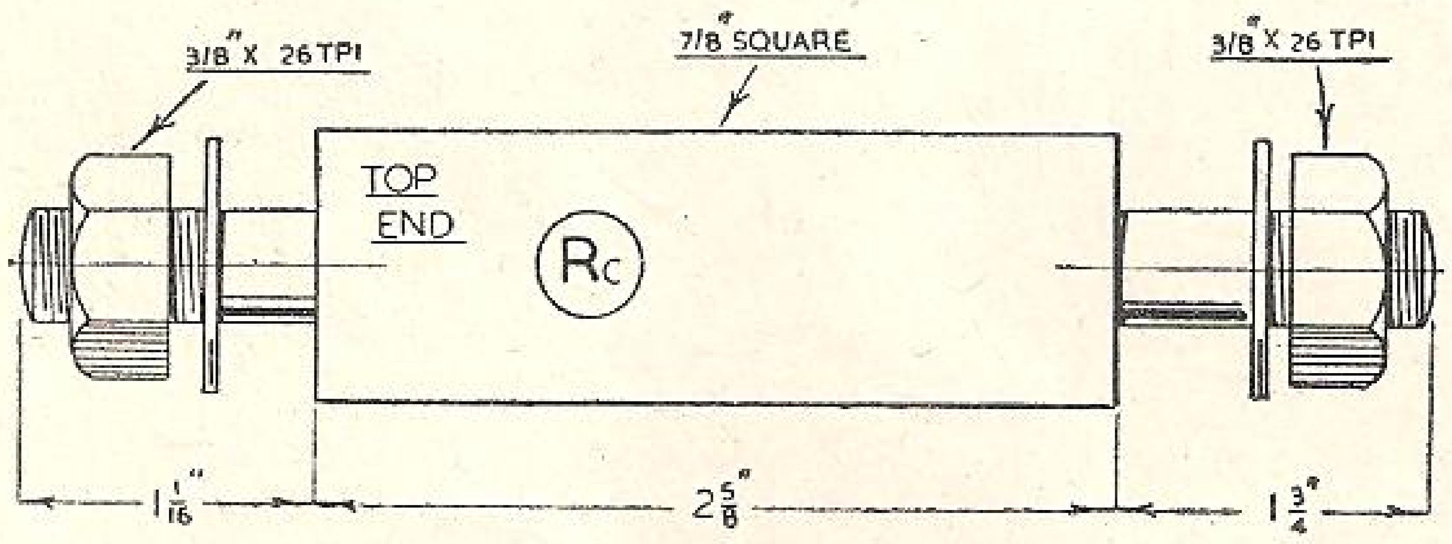


Fig. 30. The frame pillar

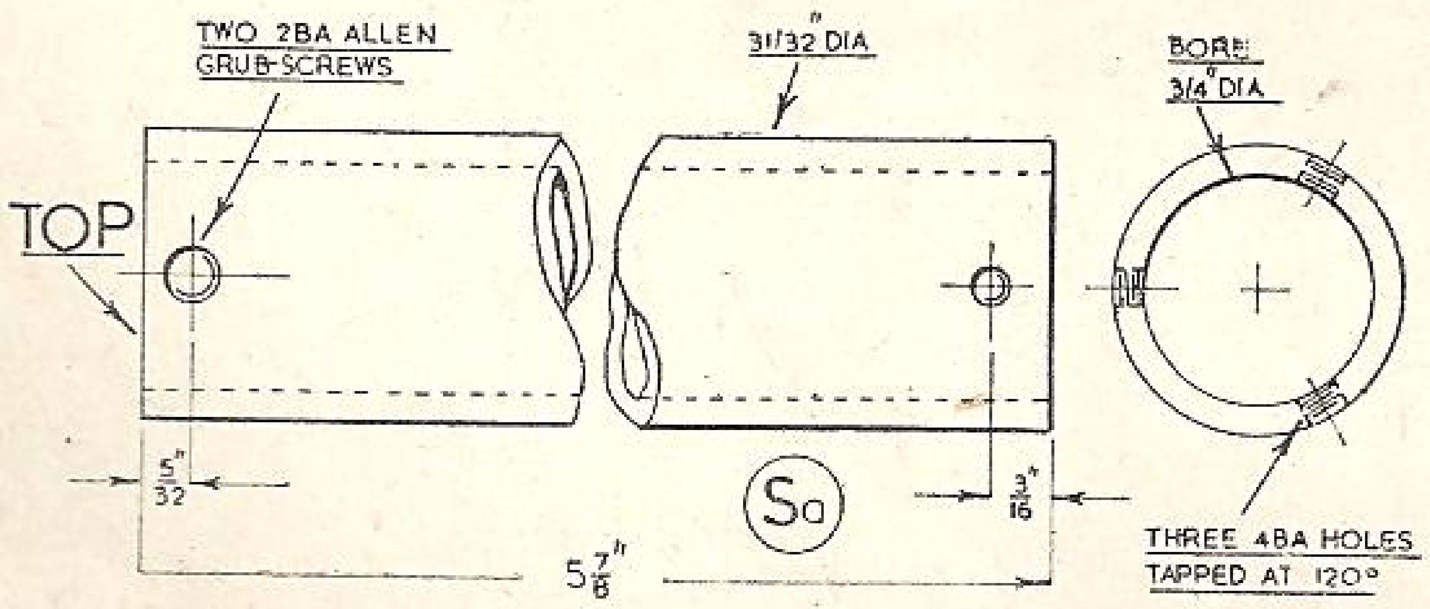


Fig. 33. The cylinder

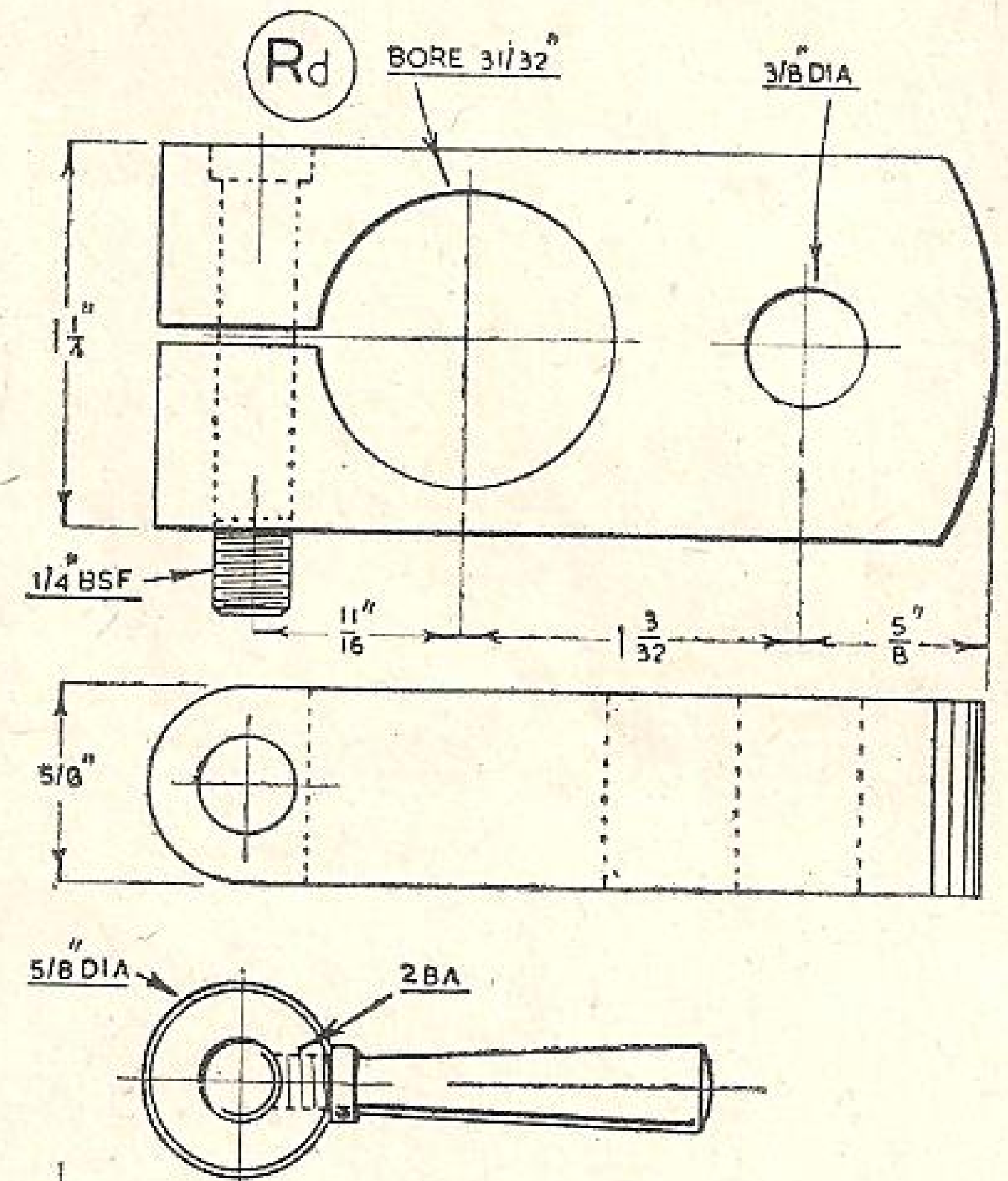


Fig. 31. The cylinder bracket and clamp-bolt

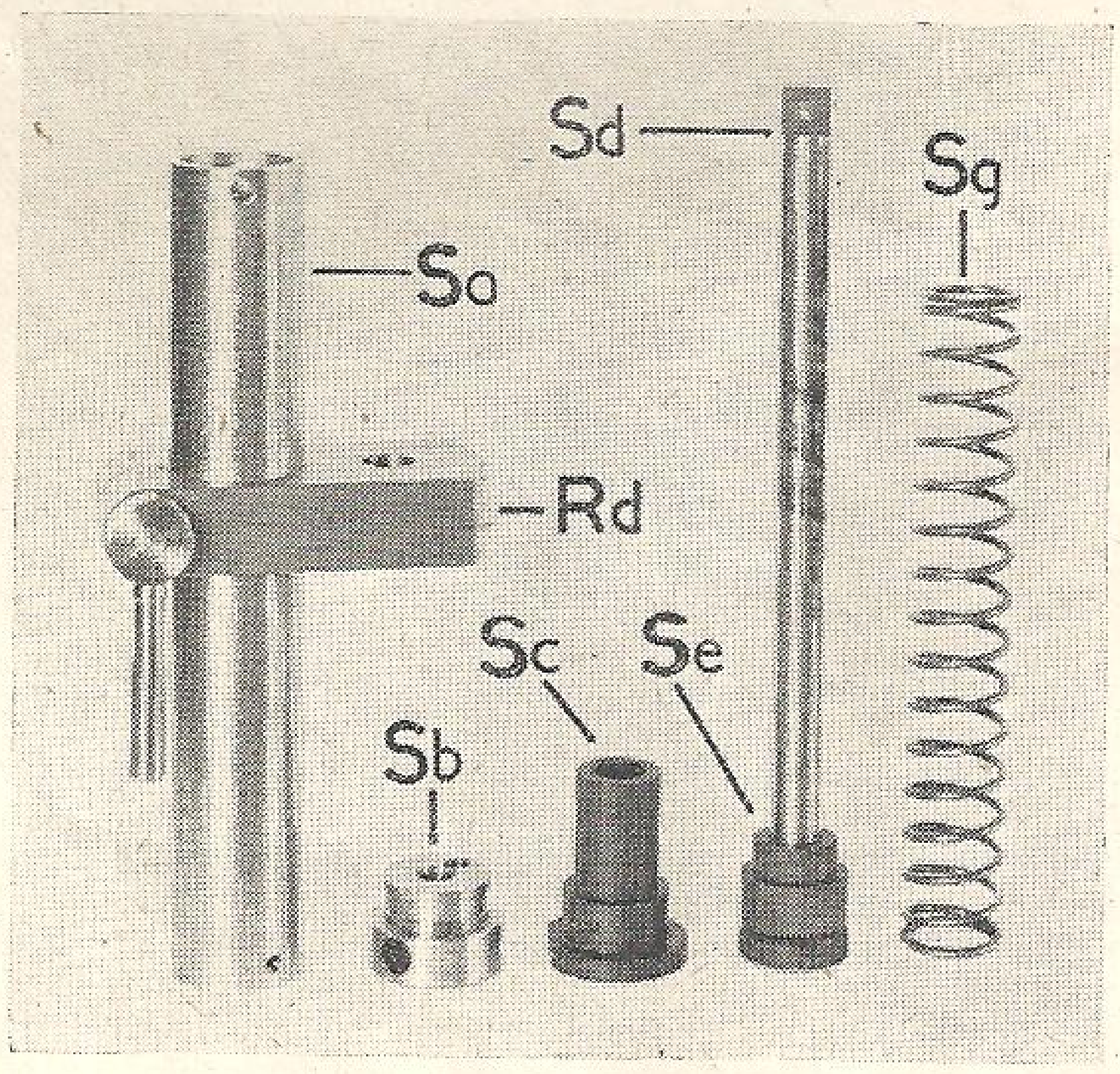


Fig. 32. The cylinder with its fittings

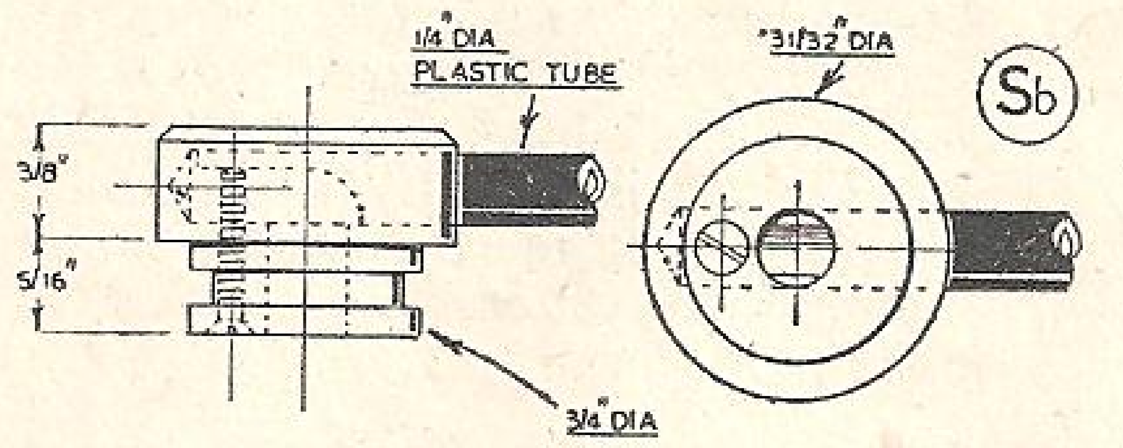


Fig. 34. The cylinder cap and air-line fixing

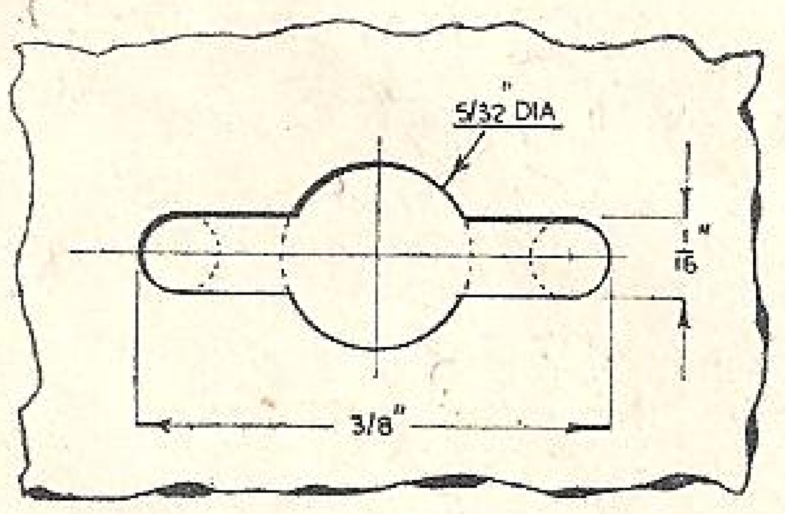
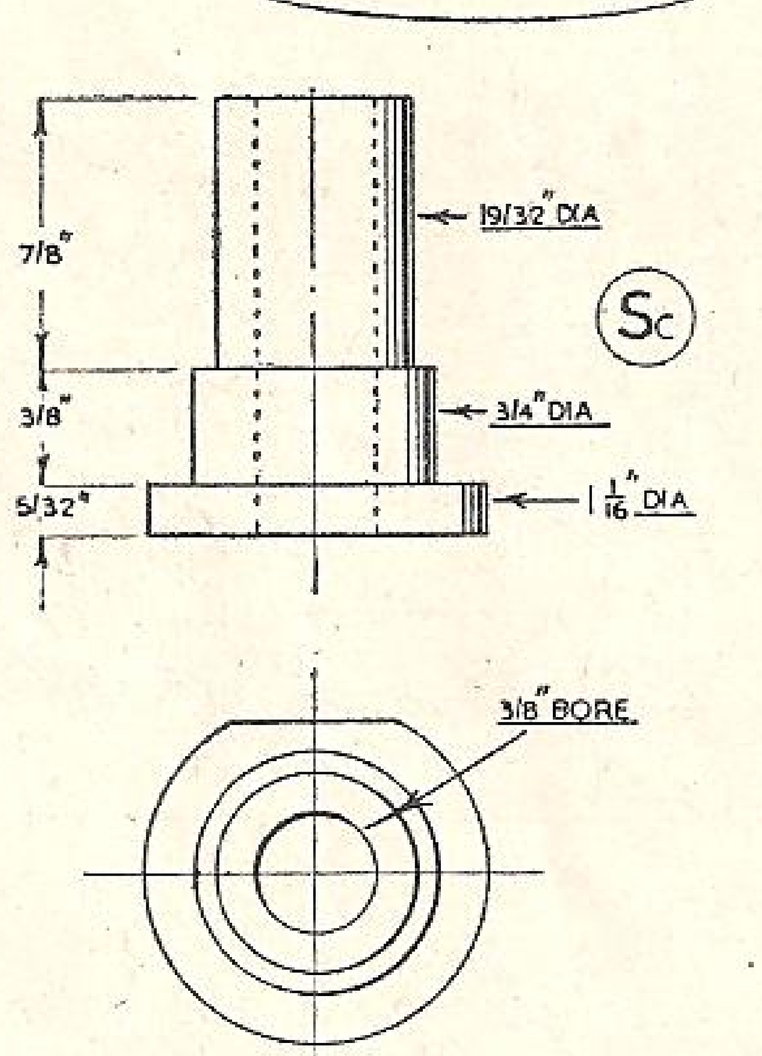


Fig. 38. Showing the dimensions of the blade slot in the saw table



Right: Fig. 35. The piston-rod guide bush

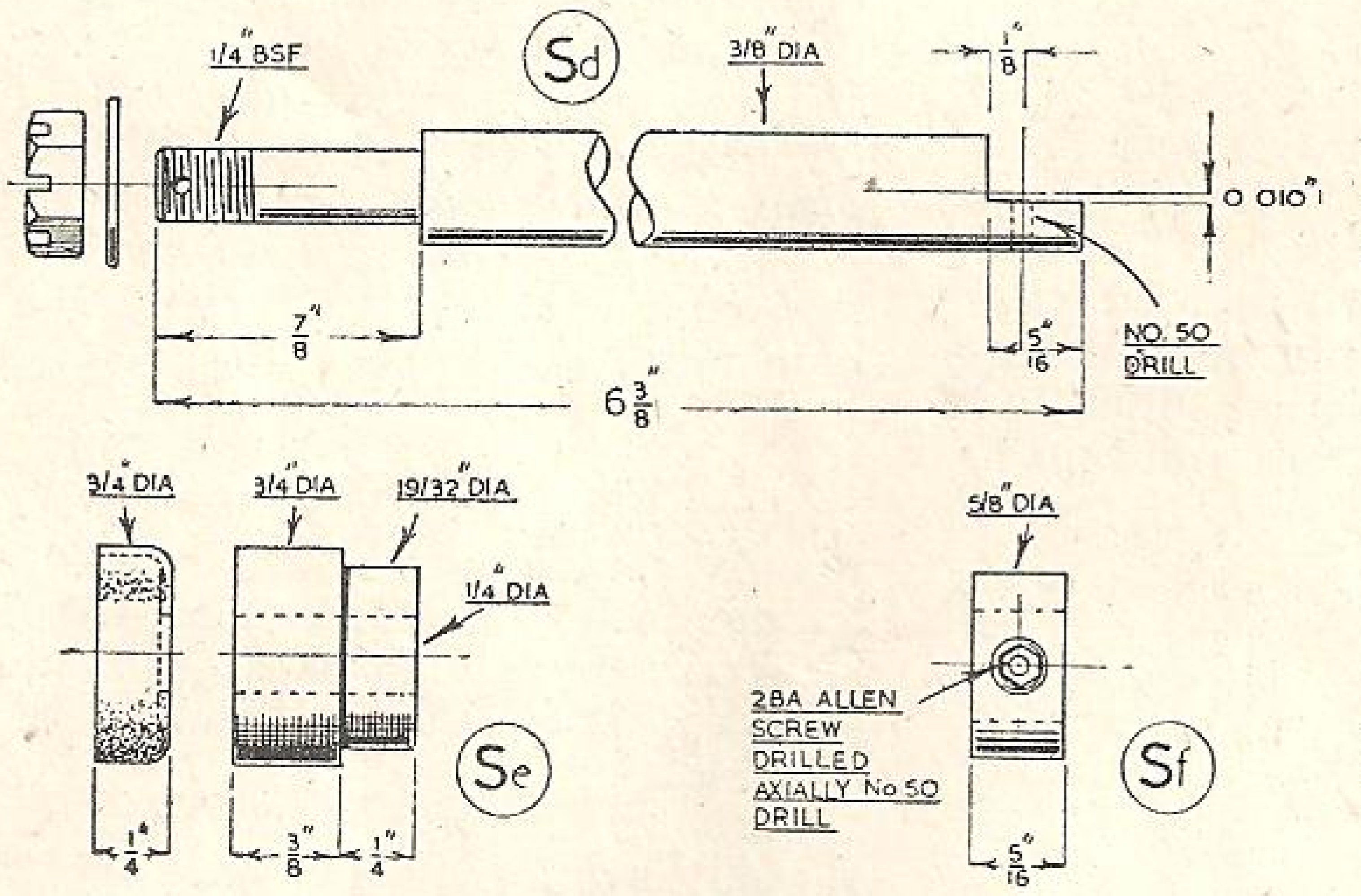
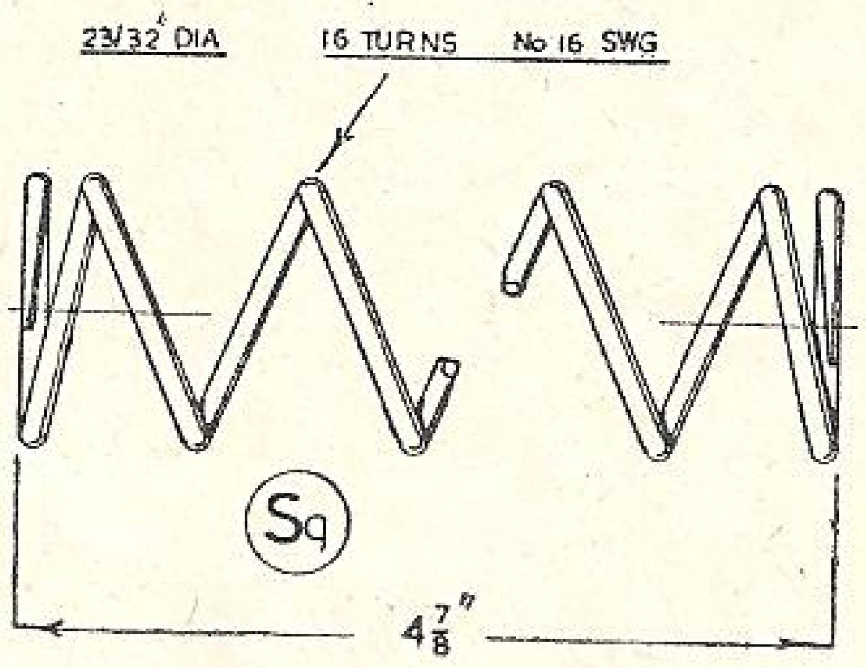


Fig. 36. The piston-rod—Sd; the piston and cup-leather—Se; the saw blade clamp collar—Sf



Right: Fig. 37. The blade tension spring

The Frame Pillar—Rc

This part is dealt with in the same way, but it is shouldered down at both ends for mounting in the frame arm and for carrying a bracket at its upper end.

The Cylinder Bracket—Rd

This component can now be fitted to the frame pillar, but the bore at the outer end should be machined later to fit the finished cylinder.

This form of built-up construction for the saw frame will be found amply rigid if the fitting is reasonably accurate; moreover, it has the advantage that some final adjustment of the alignment of the saw blade in relation to the table, can be made by altering the setting of the various joints. However, every care should be taken, by checking from time to time, to ensure that the parts are correctly made and fitted; the saw blade will then come automatically into line with the other components in the finished machine.

The cylinder, made of heavy-gauge steel tube, serves as a guide for the piston assembly forming the upper attachment of the saw blade. The cylinder and piston also act as an air pump for blowing away the swarf collecting on the work and obscuring the marking-out lines. Where a length of commercial tubing is used for making the cylinder, the bore should be smoothed with an abrasive lap.

For this purpose, a wooden rod is made a loose fit in the bore and its end is split and then expanded with a wedge to give a working fit and take up wear. The rod is driven in the lathe and, after the abrasive has been applied, the tube is worked to and fro by hand. Smoothing of the bore is needed to check wearing of the piston, and reasonable air-tightness is obtained by fitting a leather cup-washer of the kind used in cycle pumps. Both the piston (*Se*) and the guide bush (*Sc*) at the lower end of the cylinder are made of Tufnol, as this material requires no lubrication, and is highly resistant to wear.

The spring (*Sg*) fitted to the piston-rod tensions the saw blade and maintains the tension during the return stroke. Too strong a spring will cause needless wear of the working parts, but if the spring is too weak, a light saw blade may tend to buckle on the return stroke. The initial tension on the blade is set by adjusting the position of the cylinder in its clamping bracket.

The collar (*Sf*) for anchoring the upper end of the saw blade is identical with that already fitted to the drive-rod at the lower end. The plastic tubing, forming the air line, is made a push-fit in a hole drilled nearly across the cylinder cap (*Sb*), and the scarfed end of the tube is secured by means of a pointed grub-screw. The air nozzle and its holder are made at a later stage, after the saw guide has been fitted.

Usually there should be no difficulty in determining, by direct measurement, the exact position of the slot in the table for the passage of the saw blade, but if there is any doubt, it is best to drill a $\frac{1}{16}$ in. diameter trial hole at the estimated centre. A length of rod is then passed through the hole to check its position, and any correction is made accordingly. The table slot should be kept as small as possible, and should just give working clearance for the thickest blade used.

The pinned varieties of Eclipse saw blades are most suitable for use in the machine; these are fitted with a driving pin at either end to anchor the blade in the holes drilled in both the driving collars and their set-screws. It will, however, be found necessary to shorten the pins by filing their ends, so that they will enter the drive collars and will also pass through the table slot.

After a saw blade has been fitted, the machine can be given a trial run, but sawing should not be attempted until the attachment for guiding the blade and taking the cutting thrust has been added.

(*To be continued*)

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with :

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

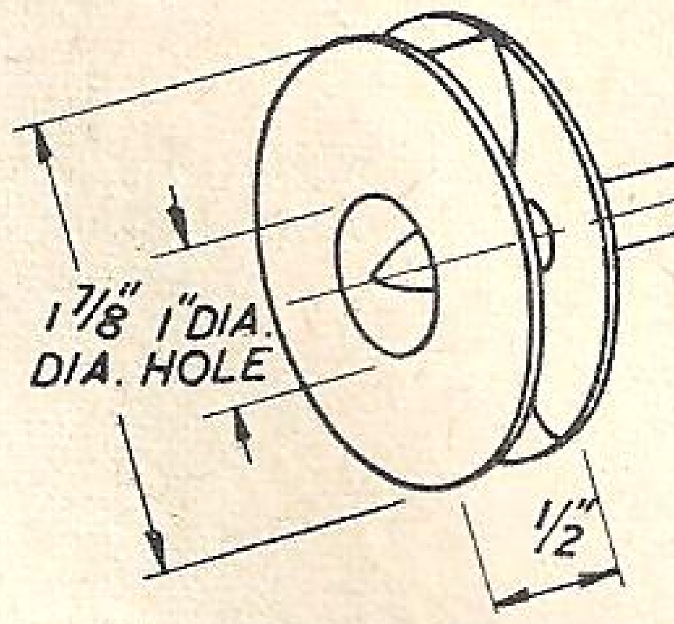
Centrifugal Pump

I have just built a centrifugal-type water pump for use in a garden fountain, (the drawings, not to scale, are reproduced herewith). It does not come up to standard in performance, and will only produce a jet a few inches high. The pump is driven by a $\frac{1}{16}$ h.p. squirrel-cage motor, and runs at approximately 1,800 *r.p.m. The same motor had previously driven another centrifugal pump which produced a jet of* 5-6 *ft. high. I am using standard $\frac{1}{4}$ in. gas pipe to connect up the pump. A suction pipe is fitted with a non-return valve, and the actual pump is sunk in the ground below the level of the water.*

A.J.S. (Greenford).

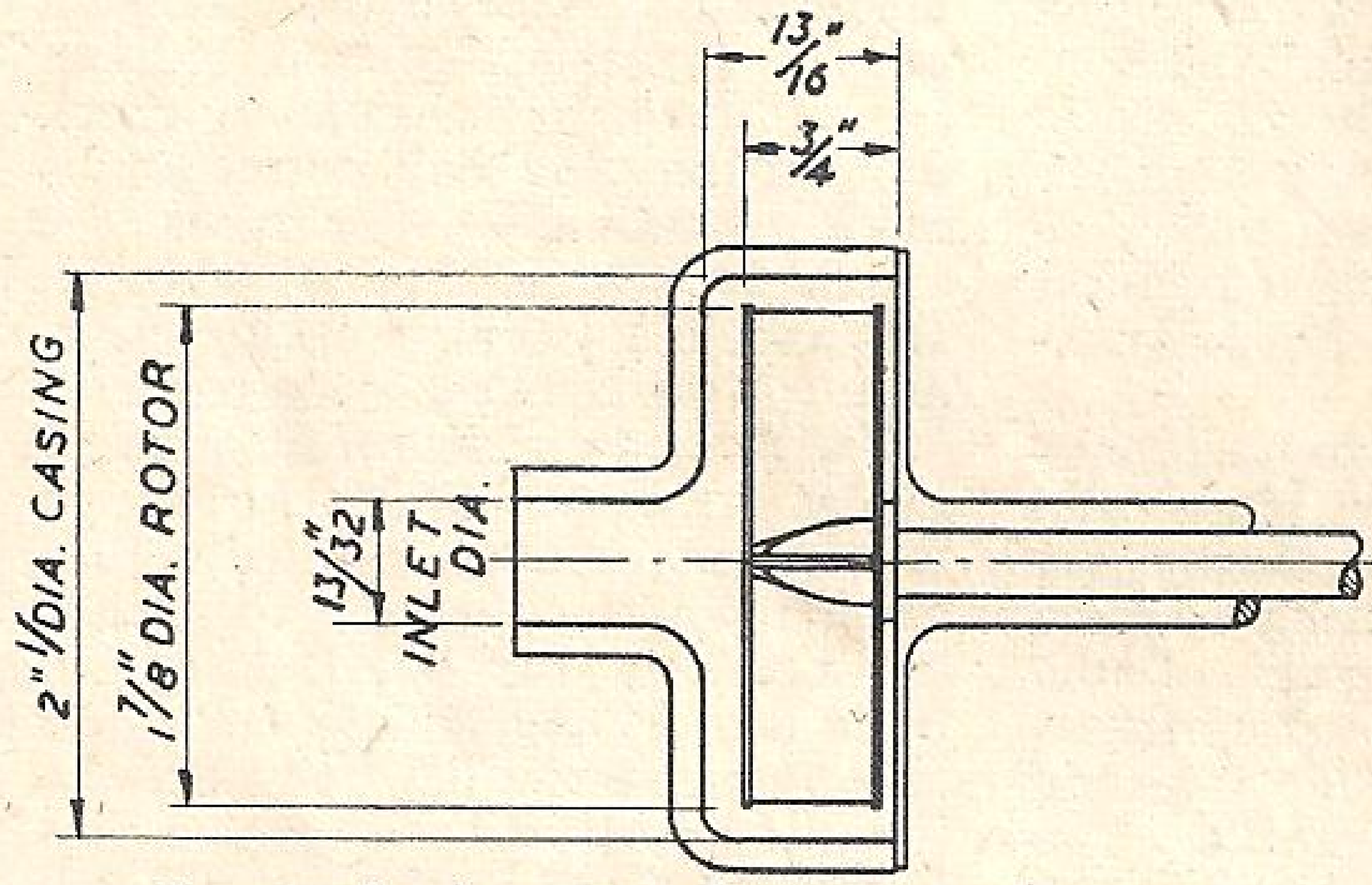
It would appear to us that the reason why this pump is inefficient is because of the excessive side clearance in the casing. It will be realised that the centre portion of the pump casing will be at the lowest pressure owing to the suction at the inlet, whereas the delivery space around the outside of the rotor will be at a considerably higher pressure.

In your design there is a fairly wide space for the water to return to the low pressure zone. Generally, this applies whether the rotor is shrouded or otherwise, but in practice shrouded rotors can be run at a somewhat higher clearance than the open type. This should not, however, be more than is absolutely necessary to obtain free running of the rotor. For the maximum efficiency, the shape of the casing should be a spiral curve, so that the clearance increases from a minimum near the angle of the outlet to a maximum where it runs out into the tangential discharge pipe, but this is of much less importance than the side clearance.

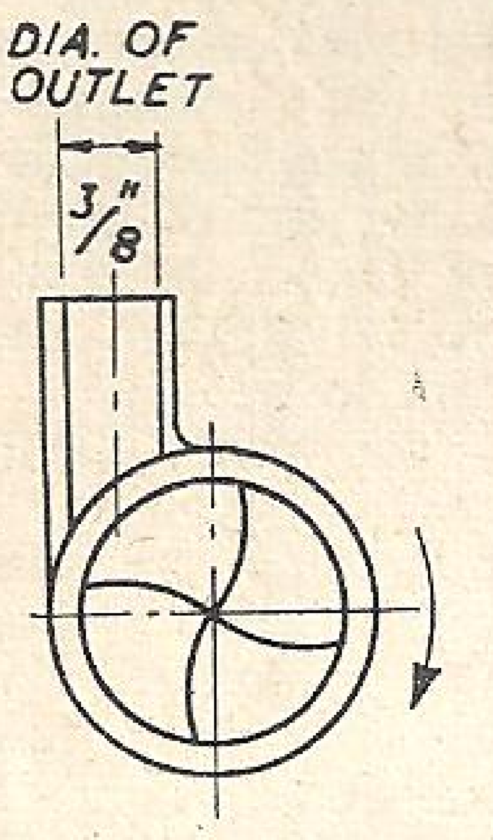


Shrouded rotor

A pump of this type should be quite capable of producing the results you require, provided that a suitable size of jet nozzle or nozzles is used.



Longitudinal section of pump as constructed



End view of rotor and casing

A very important point is that the inlet to the pump should not be in any way restricted, and, therefore, the $\frac{1}{4}$-in. gas pipe specified will be too small if used on the inlet side, and we recommend nothing less than $\frac{3}{8}$-in. gas pipe. It is also questionable whether a non-return valve, even of the lightest type, may not restrict flow, and generally speaking, it is best to dispense with this and locate the pump inlet below the water level wherever possible.

Press Fits

I have endeavoured to make a fabricated crankshaft by press-fitting steel shafts into steel webs, but have been unsuccessful owing to the metal of the shafts ploughing up as the web is pressed on. The diameter of the shafts is $\frac{1}{2}$ in. Can you tell me, please, what should be the correct allowance for a press fit of this size, and how I can prevent the metal abraiding ?

V.H. (Bolton).

The usual allowance for press fits may be taken to be about 0.0015 in. per inch of diameter, and for a shaft of the size you require an allowance of 0.001 in. should be suitable.

Parts to be press-fitted together should have a high, polished finish, and should be lubricated with oil, or a mixture of oil and white lead, during the pressing operation. If you are attempting to fit the parts dry, this is the probable cause of the ploughing up of the metal.

Blackening Brass

I have recently tried to blacken some brass instrument parts by chemical means, using a solution of 1 *oz. of sugar of lead,* 1 *oz. of hyposulphite of soda, in* 1 *pint of water, used hot. I am unable to obtain a deep black finish all over, and the articles present a mottled appearance. Can you advise as to where I may have gone wrong ?*

J.M.W. (Rochester).

Most failures in the chemical colouring of metals are due to inefficient preparation of the metal, so that it is not chemically clean before colouring operations are commenced.

First, all grease *must* be removed, either by dipping in benzine, or by boiling in a solution of one part caustic soda and ten parts water. Parts must not be touched by hand, but handled with tongs or wires.

This process must be followed by chemical cleansing in the following bath : 100 parts concentrated sulphuric acid and 75 parts nitric acid. A few seconds' immersion is sufficient, after which the parts should be well washed in running water, and on no account touched by hand or placed upon a greasy surface.

BY TRACTION ENGINE THROUGH LONDON

By G. Romanes

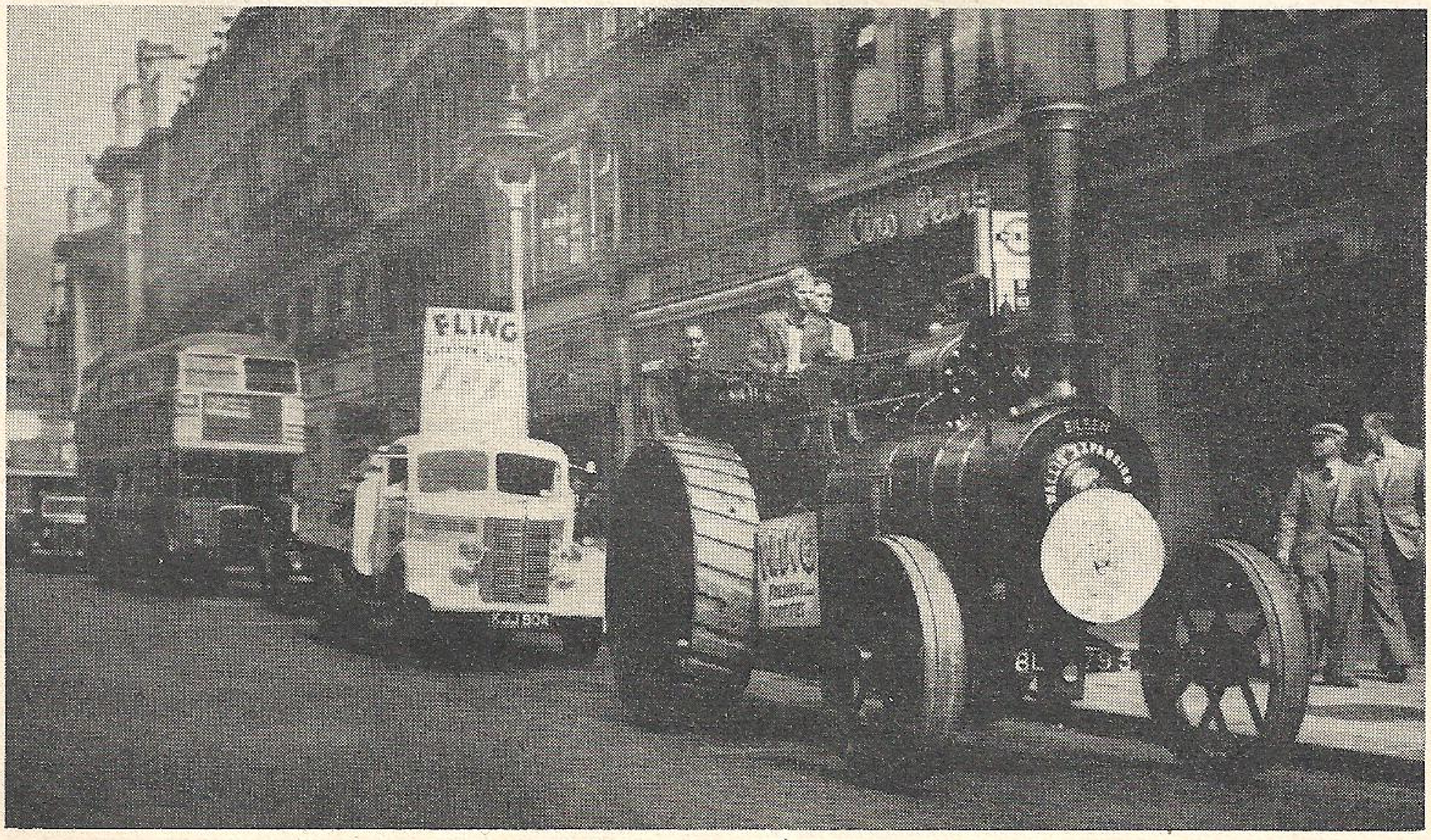
EILEEN-THE-ERRING has been my companion for some years now. She is a traction engine from Wallis & Steevens, a 7 n.h.p. expansion engine, whom I rescued from the County War Committee and put her into retirement. She ceased to be used as a purely agricultural engine and has become an adventuress. Together we went to Nettlebed to race three years ago, and she caused me to cross the path of the Law to my cost and everybody's amusement. On top of that she lost the race, but she instituted a new sport. The next year she fell off a lorry, and this year she has borrowed an idea from the Ski Club and won a slalom race. Not content with this record, she was invited to London to the "M.E." Exhibition to announce the presence there of a refreshment beverage.

We went to London in steam, but were carried there on a low loader. We unloaded in Portland Place at 11.0 a.m. and donned three placards. The sun shone on our new paint and the brasswork glittered. We set off in fine style with nearly half a glass of water and 100 lb. of steam. At the first traffic light, a bus tried to nip in front of us on the yellow and *Eileen*, living up to her name, scared my wits out by kissing it, in spite of full reverse. Luckily, the conductor did not make a fuss and we went on to Oxford Circus where we were waved across by the police against the lights. It is cobbled there and very rough going even on springs. Regent Street was taken in our stride, because we had a steersman and a rear lookout, Mr. Frank Upton, both of whom were busily engaged navigating a course through the traffic. This task is not rendered any easier by the lack of quick-application brakes when everyone else in the road has them. We came to Piccadilly Circus and encircled Eros without incident, only to be stopped in Piccadilly itself for transgressing the bye-laws about advertising.

Here the wait upset my steaming calculations, and she started to blow off, despite an open fire door and full injector. We were allowed to proceed after removing the offending placards and I remember wondering if the people in the Ritz would ever appreciate life as I was at that moment while passing it! We took water (60 gal.) from a hydrant in Grosvenor Place, more to please the Water Board man, who was beginning to look almost tearfully as though his day was being wasted, than for any other reason.

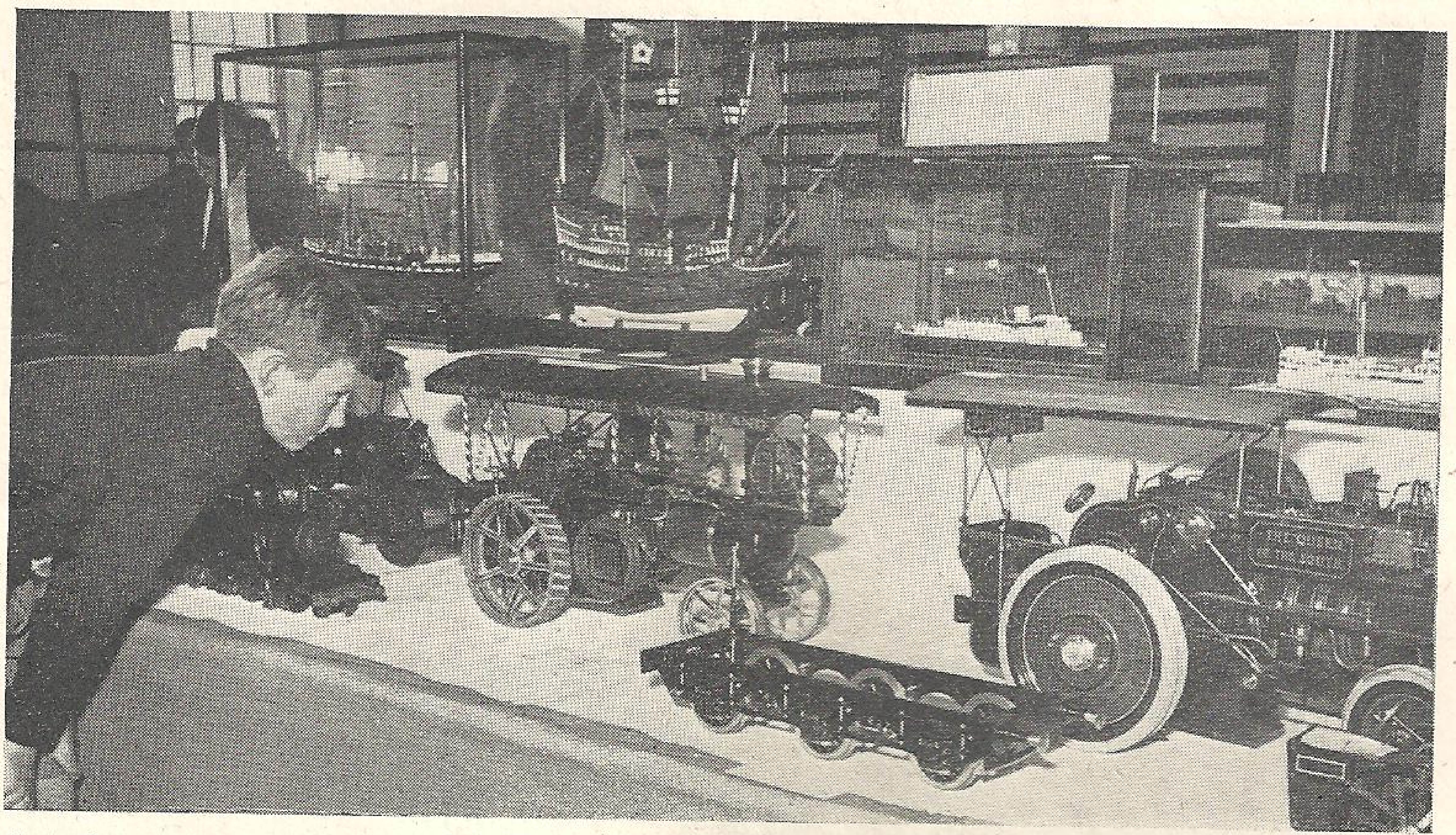
My steersman Mr. G. G. Scott, wondered if the announcements on a theatre at Victoria were being displayed in the right place and thought that we should really be carrying them, but *Eileen* went serenely on through Ashley Gardens to the Hall. Here we parked outside for the photographers to indulge themselves while we took it in turns to go into the exhibition, one of us remaining to keep *Eileen* company, as she was in steam, and to answer numerous questions. We arrived at 12.30 p.m. and after $2\frac{1}{2}$ hours we loaded up again for the homeward ride without incident, itself a remarkable feat in view of our lunch which was true to tradition.

We should like to congratulate Mr. Withers, the Exhibition Manager for the magnificent staff work providing transport, water, and moral support when dealing with the Law. Without his efforts I should never have realised a life-long ambition, or day-dream, although probably the most difficult piece of traction engine driving I've ever indulged in at any time.



The Isle of Wight Exhibition

THE Isle of Wight Model Engineering Society returned to Newport for their 1953 exhibition, after having given the island's capital a miss in 1952. Models shown were more numerous than at last year's exhibition, but not quite up to the record, although it seems that the excellence of the workmanship in all classes improves each year.



Messrs. R. G. Bosberry (Fareham) and W. G. Pope (Chichester) were the judges, and they deliberated over their job for some four hours before announcing their results. In contrast to previous years, when it has been the custom to have practically an "all island" show, models came from all parts of the Southern Federation of Model Engineers, and in addition, an excellent "OO" gauge L.N.E.R. "B.1" came all the way from Co. Durham. Naturally, there were more fresh models than ever before, and these ranged from a pair, identical, of partly completed 0-4-2 Tank locomotives, based on the old I.W. Central No. 3, by Messrs. Slaughter of Freshwater and Gilbert of Cowes, to a portion of the model of Newport Parish Church, made by the vicar of the parish. The latter gained a "Commended" from the judges, but the former were not for competition. Other interesting exhibits included an electrical "noughts and crosses" machine, which remained unbeaten throughout the course of the show, and the oldest model on show, a horizontal engine made by the late J. Samuel White of Cowes, founder of the famous firm of ship-builders, when a boy.

Probably the most interesting "exhibit" was a workshop, in full production. This was staged by Messrs. Saunders Roe, Apprentices Training School, the apprentices being *ex officio* members of the society, competing each year for a cup given by the society's president, Sir Alliott Verdon-Roe. The lads were engaged in the construction of a 25 c.c. petrol engine, designed especially for the purpose by themselves, and the workmanship displayed drew approval from all quarters. This exhibit was under the direction of the principal of the school, Mr. V. T. Stevenson.

The County Director of Education, who presented the awards was full of praise for the exhibition, and stated that to come along was an education in itself.

The Championship Cup for the best model in the show went to Mr. S. Slade for his $3\frac{1}{2}$-in. gauge G.W.R. 9400 Pannier Tank, and the Visitors Cup was won by Mr. J. Wallace for his 1-in. scale model jeep, built in the Far East.

★ *Our Cover Pictures*

Readers of *THE MODEL ENGINEER* are invited to submit for consideration photographs which may be suitable for cover pictures. The subjects must be within the scope of this journal and reference to the covers of this year's issues of the "M.E." will give an indication of the type of photograph preferred. If accepted for publication, a reproduction fee of two guineas will be paid.

Prints should be addressed to . . .

The Managing Editor
THE MODEL ENGINEER
19-20 Noel Street
London, W.1

WITH THE CLUBS

West London Society of Model Engineers

The club, in future, will be known as the "Willesden and West London S.M.E." but the address will be the same, that is, St. Judes Church Hall, Lancefield St., off Kilburn Lane.

On September 12th and 13th, the club held its really big outdoor event at the Willesden Show. Not only did we have a track running to full capacity, on both days, but we also had a good number of exhibits on view, both finished and unfinished, in one of the tents of the show.

Among the four engines running was the very fine Halton tank. The club's *Ajax*, though not quite finished, showed her real pace on the track for the first time.

The weather was good on both days and all members gave their support and deserve thanks for their work both in the tent as well as assisting at the track.

New members are always welcome and if they call at the clubroom any evening they will find somebody there who will do his best to assist in all ways possible. Although the clubnight is a Wednesday, the room is open and all is available on six days a week. The clubroom is now well supplied with tools, as well as three lathes and two vertical drills.

The next regular meeting will be held at the clubroom on Wednesday, October 28th.

Hon. Secretary: C. S. Dibble, 96a, Holland Road, Harlesden, London, N.W.10.

Ashford & East Kent M.E.S.

On September 23rd, members met at the headquarters to compete for the first time for an annual award of £5, generously donated by the president, Dr. B. Roberts. The second prize of £1 was awarded from club funds. The results were as follows: (1) J. Hanson, "Britannia" class loco. (£5); (2) K. Linkirs, "Schools" class loco. (£1); (3) L. Chaney, L.N.E.R. Pacific (highly commended).

The judges were Major Dunbar and Messrs. Rumens and Noble.

At the general meeting held on the same evening, final details for the forthcoming combined societies exhibition, in which we shall be taking part, were discussed. This is to be held at the Drill Hall, Ashford, on Friday and Saturday, October 16th and 17th, under the auspices of the Ashford Chamber of Trade.

Hon. Secretary: C. B. Butcher, 63, Hythe Road, Ashford, Kent.

Wakefield & District S.M.E.E.

We are holding an exhibition of models of all kinds in Service House, Providence Street, Wakefield, on Friday, Nov. 6th, from 3 p.m. to 10 p.m. and Saturday, November 7th, from 11 a.m. to 9.30 p.m.

Members are asked to assist us with models and help in arranging them for this event.

We shall be glad of the loan of models of all kinds from local societies and their members will be very welcome at the exhibition, but make yourselves known to any of our members at the stands or contact the Hon. Secretary: J. C. Lea, A.M.I.R.T.E., "Struma," Park Lane, Pontefract.

Bolton & District S.M.E.

The society has been re-constituted and will in future hold meetings in the Co-operative Hall, Bridge Street, Bolton, at 8 p.m., on the last Monday of each calendar month. It is hoped that several interesting lectures will be given on varied subjects during the forthcoming winter session.

That grand old model-maker, Mr. T. P. Longworth, has consented to continue as president, and our long-service treasurer, Mr. P. Smith, will continue to hold that office.

On Monday, November 30th, there will be a members' private exhibition, when the C. A. Hays Memorial Trophy will be awarded to the considered best exhibit by a member of the society.

Old and new members will be cordially welcomed at any of the monthly meetings.

Will other societies, etc., kindly note the new secretary's name and address.

Hon. Secretary: M. C. B. Arthur, 5, Limefield Road, Smithills Dean, Bolton.

Topsham Model Engineering Society

The three-day exhibition we held at the Church Institute Rooms recently proved very successful, especially as it was our first attempt. The society has benefited quite a bit financially and several new members have joined us as a result.

We hope to hold another exhibition in two-three years' time when we expect to have a complete new lot of models on show. With the exception of an odd one or two, all the models, etc., were home-made; none had been borrowed from outside clubs.

Hon. Secretary: G. W. Bell, Pinehurst, Exton, Devon. Phone: Topsham 3194.

Trying a little persuasion in the Steering Competition at the West London Model Power Boat Club Regatta at the Round Pond, South Kensington on a recent Sunday

THE MODEL ENGINEER DIARY

October 19th, 20th, 21st, 22nd, 23rd. —Cambridge & District Model Engineering Society.—Model engineering exhibition at the Corn Exchange, Cambridge.

October 21st, 22nd, 23rd and 24th.—Huddersfield Society of Model Engineers.—Exhibition in the Drill Hall, St. Paul's Street, Huddersfield. Open from 10.30 a.m. to 10.0 p.m.

October 31st.—Marlow Society of Model and Experimental Engineers.—Annual exhibition of models and handicrafts at the Church Hall, Marlow, Bucks.

November 6th and 7th.—Shrewsbury Society of Model and Experimental Engineers.—Exhibition at the Technical College. 7 to 9 p.m., first day; 2.30 to 9 p.m., second day.

November 6th, 7th.—Wakefield Society of Model and Experimental Engineers.—Exhibition of models at Service House, Providence Street, Wakefield. Open from 3 p.m. to 10 p.m. on November 6th and from 11 a.m. to 9.30 p.m. on November 7th.

November 28th, 30th, December 1st, 2nd, 3rd, 4th and 5th.—Glasgow Society of Model Engineers.—Exhibition at the Christian Institute, 70, Bothwell Street, Glasgow. Opening 10.30 a.m. to 10 p.m. first day; thereafter 10 a.m. to 10 p.m. daily.

NOTICES

The Annual Subscription is £2 2s. 0d. post free, to all parts of the world.

The Managing Editor invites correspondence and original contributions on al small power engineering and electrica subjects. Correspondence and manuscripts should not be addressed to individuals, but to the Managing Editor, The Model Engineer, 19-20, Noel Street, London, W.1.

Private: 3d. per word. Trade: 6d. per word. Minimum 12 words. Use of box 1s. 0d. extra.

THE MODEL ENGINEER

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"Impetus" machines, wood planers, motorised drills, belt sanders, electric motors, paint sprays, air compressors, circular saws, etc. Catalogue.—JOHN STEEL, Castlefields, Bingley.

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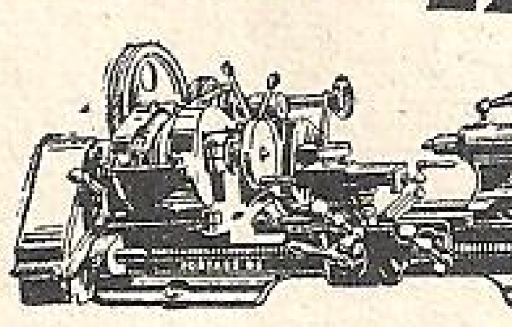

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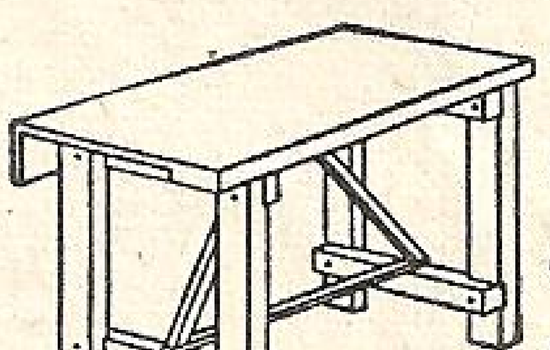

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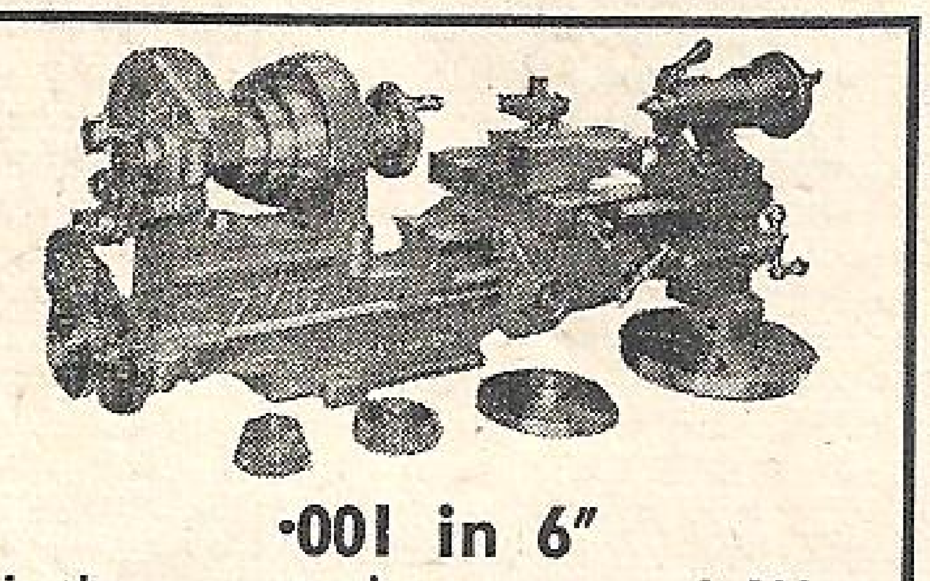

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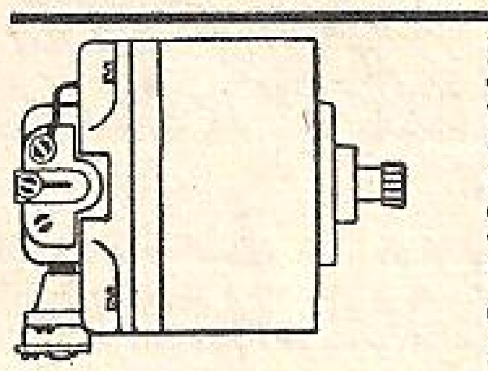

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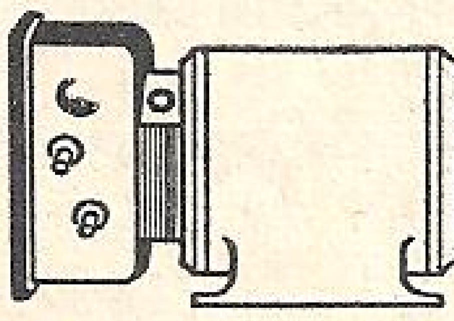

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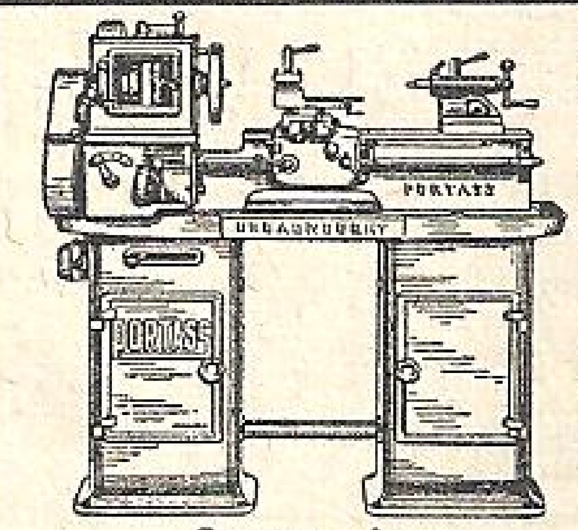

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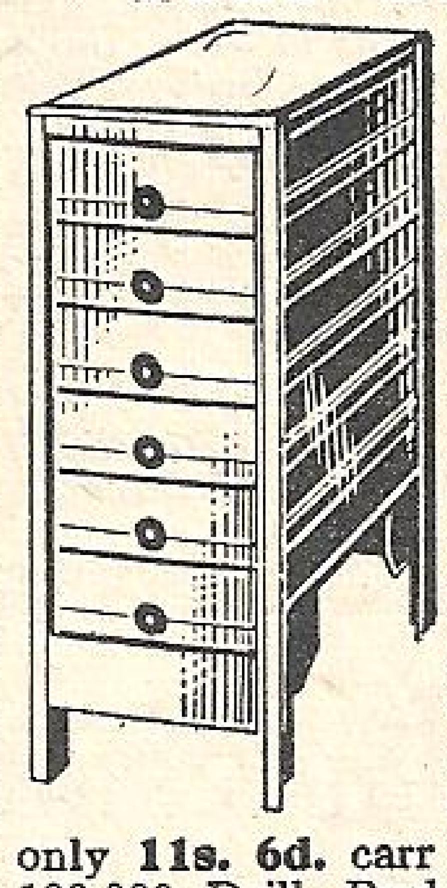

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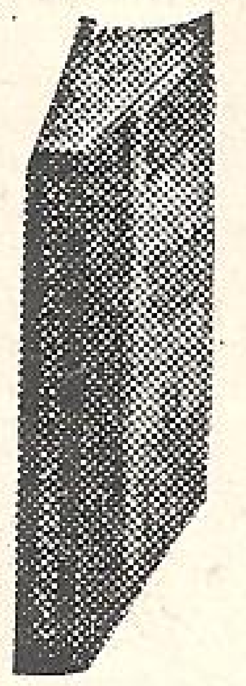

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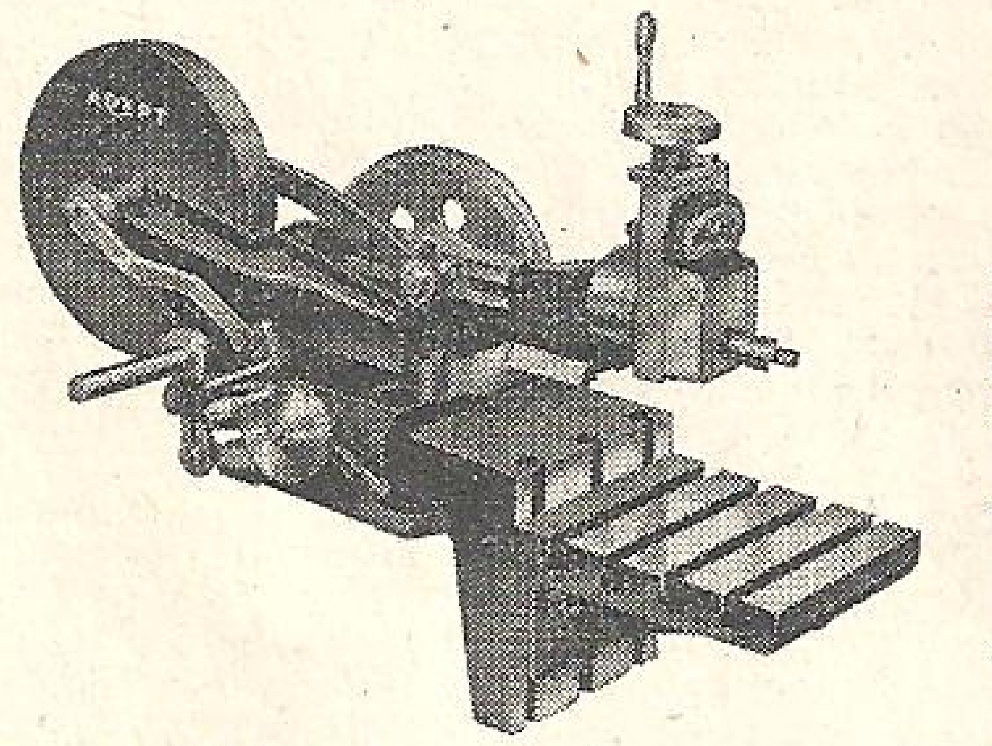

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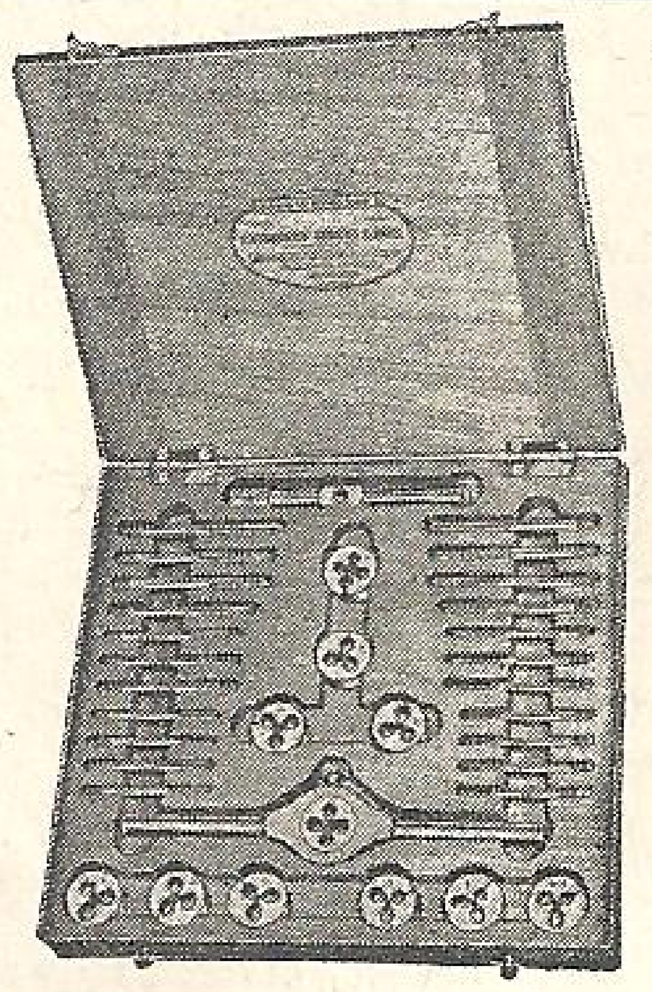

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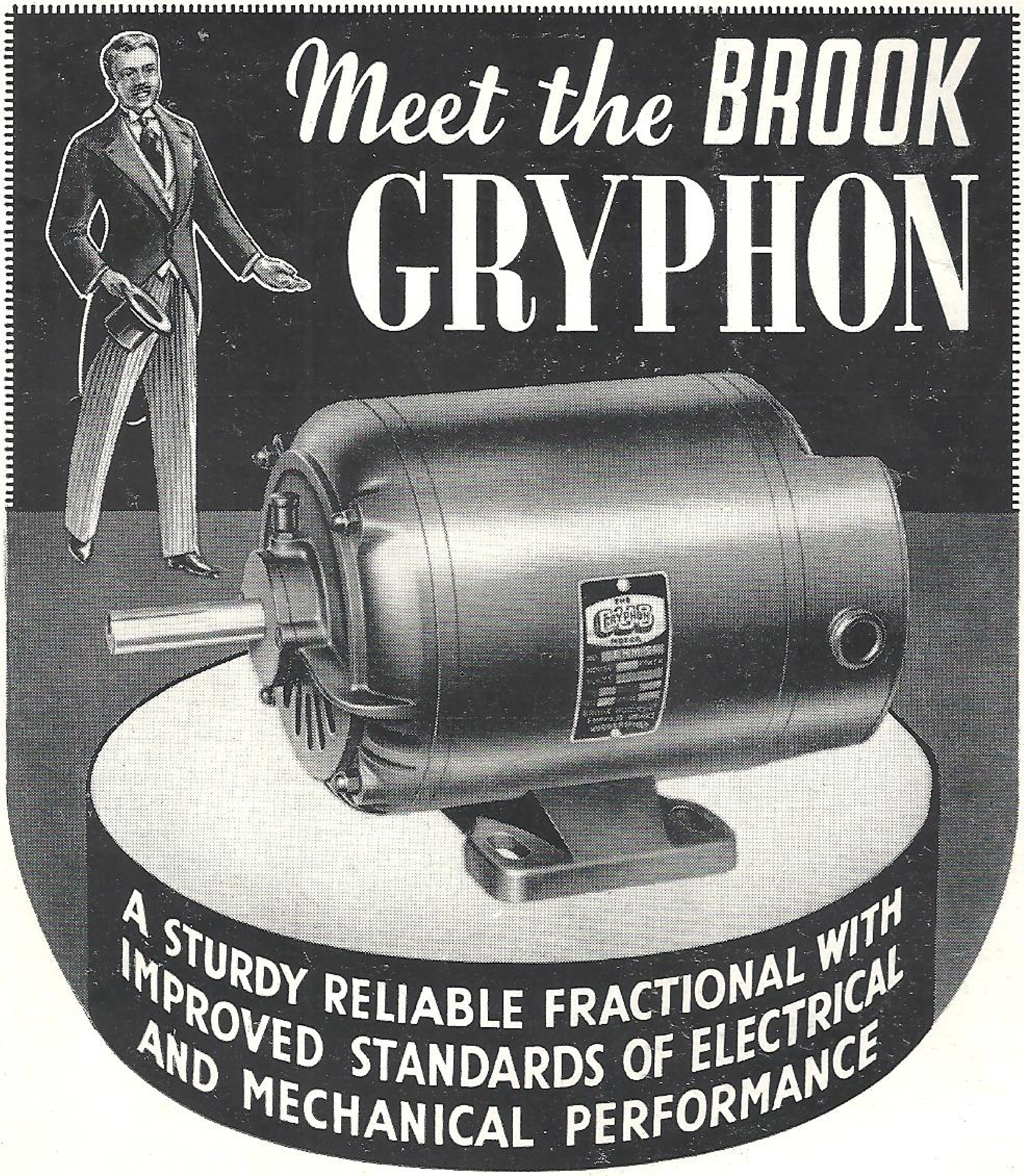
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Table VII. Commercial Forms of Solder

Type	Size: Length	Size: Section	Flux incorporated	Chief application and remarks
Bars (plumbers' sticks)	12" approx.	$1\frac{1}{4}" \times \frac{3}{16}"$ approx.	None	Plumbers' solder approx. 1 lb. in weight, for wiped joints, etc.
Body solder	By weight		—	Coachwork (metal) repairs
Ingots	By weight		None	Solders for dipping baths
Sticks (tinman's)	16" approx.	Rhomboid $\frac{1}{2}"$ wide	None	Approx. 4-8 ounces
Strip	24"	D $\frac{1}{8}"$ wide (approx.)	None	For blowpipe work weight 8 ounces approx
Wire	Spooled (see table) or carded	12-18 s.w.g usual. Also finer gauges	None	General purpose light work
Cored	Spooled (see table) or carded	Wire 10 s.w.g. upwards	Non-corrosive* resin	Electrical and instrument work
Tape	Carded or spooled	$\frac{1}{8}$-$\frac{3}{8}"$ wide	Non-corrosive† resin	General household work, mass production assembly, etc., melted by match
Foil	Spooled or Sheet	.005 in. average	None	Mass production work, oven soldering small assemblies
Powder	—	—	Powder Sal-ammoniac (usual)	Consists either of powdered tin or solder plus solid (powdered) flux
Paste	—	—	Corrosive or Non-corrosive	Consists either of powdered tin or solder suspended in liquid or paste flux

* Incorporated as cores within wire section. † Incorporated as cores within section.
NOTE.—The flux content of "cored" solders normally averages between 2.5 and 3.5 per cent. by weight, if flux is of activated type. A higher proportion is necessary with non-activated fluxes.

Table VIII. Length per lb.—Wire Solders

Wire size: s.w.g.	Wire size: Diameter	Solder (Tin/Lead proportions): 60/40	50/50	45/55	40/60	30/70	20/80
	in.	ft.	ft.	ft.	ft.	ft.	ft.
10	.128	24.5	23.5	23.25	22.75	21.5	20.75
12	.104	37.25	37.25	35.25	34.5	32.75	31.5
13	.092	47.5	45.5	45	44	42	40.5
14	.080	62.75	60.25	59.5	58	55	53.25
16	.064	98	94.25	93	91	86.5	83.5
18	.048	174.5	167	165	161	154	148
19	.040	250	241	238	232	221	212
20	.036	310	298	294	287	273	263
22	.028	512	492	486	474	452	436

E.G.—One pound of 14 s.w.g. wire solder (60/40) is equivalent to 62 ft. 9 in. length.

FOLD ON THIS LINE

Solders and Soldering

THIS supplement does not set out to describe the mechanics of soldering or how to go about making soldered joints, since it is is assumed that the average model engineer is already well acquainted with the technique involved. It does, however, summarise a considerable amount of practical data on solders, fluxes and their applications and explain a number of points which may not be common knowledge.

The range of available soft solders is a considerable one. The "general purpose" solders have normally a tin content of between 40 and 50 per cent. A solder with a slightly higher tin content (60 per cent.) is used for most electrical work. The difference in the properties of these particular alloys is not great and it is only where mass production of soldered assemblies is involved that we find marked preferences for one alloy or the other.

The chief advantage of a 60/40 tin/lead solder, for example, is its relatively low melting point. However, since the cost of tin is some six times greater than that of lead, some manufacturing concerns may consider it expedient to use, say, a 40/60 tin/lead solder for electrical connections. The use of such an alloy is, in fact, standard in the American radio and television industry.

Whilst the choice of solder for general purpose work is seldom critical, certainly soldering is that much easier if a low melting point solder can be used. On the other hand, using a special low melting point solder (some of which will melt in boiling water) it must be expected that even a moderate rise in service temperature may affect the strength of the joint to a serious degree.

Another point to bear in mind in selecting solders for any particular job is that antimonial solders offer certain advantages for particular classes of work but are definitely harmful in other cases. For preference, therefore, the solder selected for miscellaneous duties in the home workshop should be of the non-antimonial general purpose type.

Besides the variety of different solder alloys, commercial solders are also available in a number of different forms, ranging from ingots of several pounds in weight (used principally for melting down for dipping baths) down to wire as fine as 36-s.w.g. in diameter size and flat tape or foil down to $\frac{1}{8}$ in. in width. Common forms are listed in Table VIII. In addition numerous solder preforms, solder washers and rings, etc., are made for mass production applications. There are also a comparable number of different brands and types of commercial fluxes available, nearly all of which fall into the flux categories listed in Table V, on which data a selection can be made of the most suitable type of flux (or fluxes) for the job under consideration. Most "general purpose" soldering can be covered by the use of "cored" solders incorporating the necessary flux with the solder.

Soldering Technique

THE basic technique of soldering may be said to consist of properly fitting the parts to be joined so that the space between them is sufficiently narrow to attract and retain the molten solder, making sure that the parts themselves are thoroughly clean and ready for soldering (e.g. pre-tinned); employing the right kind of flux, a suitable solder for the job together with a suitable iron or means of raising both the solder and the immediate area of the surfaces to be joined to the correct temperature.

A majority of soldering jobs in the home workshop are done with soldering irons and the electric iron is undoubtedly more widely favoured than irons which have to be heated by independent means. Apart from dirty joints, a majority of soldering troubles arise from the use of too low a bit temperature, so that the solder is not properly melted. Except for eutectic alloy compositions (which are normally used only for the low melting point solders), all solders melt in two stages on heating. On reaching a certain temperature the solder begins to melt, so that it becomes plastic or pasty. Unless there is adequate heat to raise the temperature still further to the point at which the solder melts completely a poor joint must inevitably result. For good work it is normally recommended that the bit temperature should be about 40 deg. C. higher than the temperature at which the solder alloy melts completely.

It is difficult, or even impossible, to gauge the bit temperature of an iron, nor is this particular data normally given by manufacturers in quoting the performance of an electric iron. It is, therefore, necessary to judge whether or not an iron is hot enough by experience in the manner in which it makes the solder "flow." Electric irons are certainly more convenient for small installation and assembly work, and in particular for making soldered electrical connections, but there is still much to be said for the use of indirectly heated irons for larger mechanical joints in steels, etc. Due consideration must, of course, be given to the possibility of heat damage to adjacent components if too hot an iron is employed, or if a large, hot bit is held against the joint for an appreciable period of time, as much of this heat will be conducted away by the surrounding metal.

Cleaning and degreasing play an important part in soldering. Mechanical cleaning of the parts to be soldered, by scratch brush, emery paper, filing, or even glasspapering is most effective. If the part is handled before soldering, degreasing may be necessary. Usually this can be done quite satisfactorily by swabbing over with a detergent wash, followed by rinsing under running water. Swabbing with a more powerful degreasing agent, such as an alkali type degreasing fluid or trichlorethylene may be necessary in bad cases of grease soiling.

If the type of flux used is in any way corrosive, adequate cleaning after soldering is also essential. Particularly in the case of steels, strong acid fluxes are frequently employed which should be neutralised as soon as possible after soldering by dipping or washing in an alkaline solution. Scratch brushing or similar mechanical cleaning may also be necessary to remove encrusted deposits of fused flux.

Special Techniques

WHILST some metals are markedly more difficult to solder than others, and some indeed are impossible to joint in this way, many of the so-called "difficult" metals are readily responsive to a certain type of flux and solder and possibly slightly modified technique. It is not commonly appreciated, for instance, that satisfactory soldered joints can be made to many plated surfaces, provided that the surface coating itself is sufficiently rigid or well bonded to the underlying parent metal.

A typical list of recommendations is given in the following table of which only aluminium and aluminium bronze may prove to be outside the scope of average "amateur" work. The recommendations for alloy steels are, of course, of a general nature due to the immense variety of compositions met with.

Table VI. Difficult Metals to Solder

Metal	Recommended flux (proportions in brackets)	Recommended solder	Special treatment
Aluminium‡	Air-excluding* flux (2) Phosphoric acid plus (1) Nitric acid	70/30 Tin/Zinc	Soldering temperature 400° C. Can be used for tinning
Aluminium Bronze	(1) Hydrochloric acid (1) Killed spirits	Tin/Zinc	High soldering temperature
Beryllium Copper	Resin or Lactic acid§	Ordinary	Ordinary†
Bronze	Ordinary	60/40 Tin/Lead	Ordinary†
"Alloy" Brasses	Zinc Chloride	60/40 or 50/50 Tin/Lead	Antimonial solders should be avoided
Cast iron	Zinc Chloride	Ordinary	Effective mechanical cleaning necessary.
Gunmetal	Ordinary	60/40 Tin/Lead	Ordinary†
Alloy Steels	Hydrochloric acid or Zinc Chloride	Ordinary	Pickle in Nitric acid and dip in Hydrochloric acid before tinning
Stainless Steels	(1) Hydrochloric acid (1) Zinc Chloride	Ordinary	—
Cadmium plated Surfaces	Resin types	Ordinary	Excellent soldering characteristics
Chromium Plated Surfaces	Zinc Chloride	60/40 Tin	Ordinary†
Silver Plated Surfaces	Non-corrosive resin (liquid)	Low melting point solders preferred	Very thin plated coatings removed by solution on soldering

* Normally based on Sodium Chloride, Potassium Chloride and Lithium Chloride.
† See table iv. ‡ More readily solderable with ultrasonic soldering iron. § Corrosive

Fluxes

METALS such as tin, copper, brass and, to a lesser extent, iron and mild-steels are readily solderable with a variety of fluxes. Prior to the advent of activated resin fluxes it was common practice to use an acid-base (corrosive) flux where positive fluxing action was important, cleaning after jointing to remove the corrosive elements.

By the addition of suitable activators, the modern non-corrosive resin fluxes have a comparative performance in many instances, thus reducing the importance of cleaning. It should be noted, however, that some activated resin fluxes are of the corrosive type and where it is essential to employ a non-corrosive flux the type of flux must be chosen carefully. Non-corrosive fluxes are invariably employed in soldering up electrical connections, and in fine instrument work. If necessary, mechanical cleaning of the components concerned should precede soldering.

The fluxing action of many of the corrosive fluxes (particularly a mixture of "fresh" and "killed" hydrochloric acid) may make it possible to produce sound joints on "dirty" surfaces, but this is a practice not to be encouraged. The action of most of these liquid fluxes can be improved by the addition of a small proportion of wetting agent.

Table V. Soldering Fluxes

	Name	Form	Application	Remarks
Corrosive	Hydrochloric Acid	Liquid	Soldering zinc	More effective than 'killed spirit' use half-strength acid
	Hydrochloric Acid plus Zinc Chloride	Liquid	Flux for stainless steel.	50-50 fresh and 'killed' acid
	Zinc Chloride	Liquid	Good general purpose flux	Killed' hydrochloric acid
	Zinc Chloride plus Ammonium Chloride	Liquid	Good general purpose flux	Lower fusion point than zinc chloride
	Ammonium Chloride	Liquid	General purpose	Less effective and less corrosive than above
	Phosphoric Acid Borax	Liquid Solid	Steel, copper, brass iron or steel	Normally non-corrosive
Non-corrosive	Tallow	Solid	Lead	Used in plumbed joints
	Resin	Solid	Lead, tinned iron	Also as liquid flux in alcohol solution
	Activated Resin*	Solid or Liquid	Tinned steel, copper, brass	Improved fluxing action
	Resin paste	Paste†	Lead, iron, tinned steel, copper, brass	General purpose non-corrosive flux Usually with activator*
	Self-neutralising (Aqueous)	Liquid	General purpose flux	Hydrochloric acid base for good fluxing— Incorporating self-neutralising agents

* Some activated resin fluxes may be corrosive.
† Corrosive paste fluxes are also available, based on hydrochloric acid.

The "wetting" characteristics of the solder also play a significant part in many applications. In general, solders with a high or medium tin content possess the best "wetting" properties. For treating copper surfaces the most stable coatings are produced with solders having between 40 and 60 per cent. tin. Antimonial solders wet copper less readily than the non-antimonial types, although their performance may be adequate. They are not to be recommended for jointing brass and zinc coated parts due to the brittleness of antimony-zinc compounds formed.

The question of cooling the freshly soldered joint raises a number of interesting points. For maximum mechanical strength from the joint it is an advantage to cool the solder down to about 120 to 130 deg. as quickly as possible. This inhibits the formation of large, brittle crystals in the joint metal. However, rapid cooling may tend to promote localised contractions, causing unequal stresses within the joint and consequent reduction in overall strength.

It is considered that a quick dip is a water bath immediately the solder shows signs of becoming solid is advantageous, removing and leaving the assembly to cool right down in air. For most normal purposes, however, air cooling is quite satisfactory. Typical figures for the maximum mechanical strength which may be expected from soldered joints employing different types of solders are summarised in Table I.

Table I.

Maximum Strength of Soldered Joints

Solder	Tensile strength at room temp. tons/sq in.	Tensile strength (tons/sq. in.) at 50° C.	75° C.	100° C.	125° C.	150° C.
Wood's Metal	1.6		0	—	—	—
Bismuth-Tin-Lead	2.6			0	—	—
Bismuth-Cadmium-Tin ...	3.9			0	—	—
Bismuth-Tin	4.3				0	—
Tin-Cadmium-Lead	3.4					0
Bismuth-Cadmium	3.3					0
Cadmium-Tin	4.2					
95/5 Tin/Lead	2.65	2.5	1.8	1.45	0.75	0.5
60/40 Tin/Lead	3.65	3.0	2.7	2.0	1.25	0.8
40/60 Tin/Lead	3.4	2.8	2 5	1.6	1.0	0.75
Tin-Lead-Silver: 10-88-1.5 ... ... 20-78-2.0 ... ... 30-69-1.0 ... ... 30-66.75-1.25	 2.4 2.5 3.95 3.63					

CUT ON THIS LINE

Types of Solders

WITHIN the range of so-called " soft " solders there are three basic groups of alloys, classified, respectively, as low melting point solders, soft solders and high temperature (or " hard " or high strength) solders. All are within the range of melting points readily achieved with normal soldering irons. The former are eutectic alloys of bismuth, lead, cadmium and tin in varying arrangements. Normal soft solders are tin-lead alloys, with or without the addition of small proportions of antimony. The range of solders giving greater strength and higher service temperatures are compounded from tin and lead with small proportions of silver, and possibly also antimony. One of the main advantages of an antimonial solder is that it has a higher creep strength than a corresponding non-antimonial solder. However, antimonial solders should not be used on brass or zinc since these metals tend to form a brittle compound with antimony, resulting in weak joints. True " silver solders " are quite distinct from the tin-lead-silvers mentioned and are not suitable for iron work. They have melting points of the order of 675 to 850 deg. C. and are normally fused with a blowpipe or similar apparatus.

With the range of soft solders, the point at which the solder just starts to melt (or solidifies completely on cooling) is the same (183 deg. C.) irrespective of the composition. This corresponds to the melting point of the eutectic tin-lead alloy (63 per cent. tin). However, differing proportions of the alloy result in a raising of the temperature at which the solder becomes *completely* liquid or reaches the liquidus state and corresponding bit temperatures required are noted in Tables II, III and IV.

Low melting point solders are used where it is necessary to use only low soldering temperatures. The mechanical strength of these soldered joints is lower than those achieved with ordinary soft solders, which in turn are lower than the strength of tin-lead-solder solder joints at higher temperatures. It must also be remembered that the cold strength decreases quite appreciably as the service temperature rises until, as the eutectic temperature of the alloy is approached, the loss of strength becomes even more sharply marked. Some typical strength figures are summarised in Table I.

Table II. Low Melting Point Solders

Eutectic alloy composition	Melting point solidus and liquidus °C.	Bit temperature °C.	Remarks
Bismuth-Lead-Cadmium-Tin (Wood's metal)	70	100	Good low temp. solder
Bismuth-Lead-Tin	95	125	Used with activated flux
Bismuth-Cadmium-Tin ...	103	140	Used with activated flux
Bismuth-Tin	138	175	Good solder
Tin-Cadmium-Lead	142	180	Excellent solder
Bismuth-Cadmium	144	184	Good solder
Cadmium-Tin...	177	217	Good solder

Table III. Tin-Lead-Silver Solders

Composition (%) Tin	Lead	Silver	Antimony	Melting temperature liquidus °C.	Bit temperature required °C.
10	88	1.5	0.5	290	330
20	78	2.0	—	290	330
20	77.25	1.25	1.5	260	300
30	69	1.0	—	251	291
30	66.75	1.25	2.0	249	289
30	68.25	1.25	0.5	247	287

Table IV. Soft Solders

(Tin/Lead Solders—British Standard 219 : 1949)

Grade	% tin	Antimony content %	Melting temp. liquidus °C.	Bit temp. required °C.	Applications
—	100	—	232	272	Pre-tinning
E	95	—	223	263	Electrical work
A	65	1.0 max.	186	226	Mechanical joints
K	60	0.5 max.	189	229	Electrical and tinsmith's
F	50	0.5 max.	214	254	General purpose
B	50	2.5-3.0	203	243	General purpose
M	45	2.3-2.7	215	245	General purpose
G	42	0.4 max.	232	272	Dip galvanising
C	40	2.0-2.4	228	268	General purpose
H	35	0.3 max.	246	286	Wiped joints
L	32	1.6-1.9	245	285	Wiped joints
J	30	0.3 max.	255	295	Wiped joints and dipping
D	30	1.0-1.7	248	288	Wiped joints
N	18.5	.75-1.0	275	315	Dipping solder

NOTE:—Grades A, E, F, G, H, J and K are non-antimonial solders. Grades B, C, D, L and M are antimonial solders.